John Crawford,

M. D.

Imprimendi Facultas.

Librum hunc inſcriptum *Oſteologia Nova, &c.* planè dignum cenſemus qui Imprimatur.

Gualt. Charleton Præſes Coll. Reg. Medic. Lond.

Thomas Burwell,
J. Gordon,
Will. Dawes,
Tho. Gill.
Cenſores.

Datum ex ædibus Collegii noſtri
Auguſti 29. *A. D.* 1690.

A. Wiedenthal's.

OSTEOLOGIA NOVA,
OR SOME
New OBSERVATIONS
OF THE
BONES,
AND THE
PARTS belonging to them, with the manner of their Accretion, and Nutrition, Communicated to the Royal Society in ſeveral Diſcourſes.

LIBRARY OF THE UNIVERSITY OF

#63

I. Of the Membrane, Nature, Conſtituent parts, and Internal Structure of the Bones.
II. Of Accretion, and Nutrition, as alſo of the Affections of the Bones in the Rickets, and of Venereal Nodes.
III. Of the *Medulla*, or Marrow.
IV. Of the Mucilaginous Glands, with the Etiology or Explication of the Cauſes of a Rheumatiſm, and the Gout, and the manner how they are produced.

To which is added
A Fifth Diſcourſe of the CARTILAGES.

By *CLOPTON HAVERS*, M. D.
Fellow of the Royal Society.

LONDON:
Printed for *Samuel Smith*, at the Princes Arms
in St. *Paul*'s Church-Yard. 1691.

Crawford

To the Right Honourable

THOMAS
EARL of *Pembroke*,
PRESIDENT
OF THE
Royal Society.

MY LORD,

T*Hough Ambition is one thing, that carries me to addreſs my ſelf to a Perſon of your Honour, and Ingenuity; yet there is a more common Principle of ſelf-preſervation, which concurrs, and directs me to ſeek that Patronage, which will beſpeak not only the Juſtice, but* *the Candour of every Reader. And ſeeing the* Royal Society *have ſo great a ſenſe of their happineſs, when they are to act under the influence, and conduct of ſo Wiſe, and Honourable a Preſident, I cannot queſtion my own ſafety under the name of ſo great a Patron. When I reflect upon my ſelf, that am a tender, and an infantile Author, I find nothing but fear, and diſcouragement, as I am in danger of being Overlaid by every little Cenſure; but when I conſider my ſelf under the Umbrage of a Perſon, whoſe Example, and Authority may prevail with the World to be generous, and to imitate thoſe Vertues, which they ſo much admire in your Lordſhip, this frees me from that diffidence, and timorous concern, which the cenſorious temper of the Age, and the ſenſe of my own weakneſs are apt to create.*

But although it may reaſonably be thought, and I have confeſt, that I now deſign my own ſafety, that this Treatiſe carries your Lordſhips name as an Amulet againſt thoſe cen-

ſures, which I expoſe it to; yet it will at the ſame time appear to be my duty to preſent to your Lordſhip, that, which the Relation you bear to the Royal Society, *gives you a Title to. I do therefore humbly offer, and dedicate theſe Diſcourſes to your Lordſhip as a teſtimony of that profound reſpect, which is due to a Perſon of your Quality, and extraordinary Character, and it is certain, that every Member of the Society ſpeaks the Senſe of the whole, when he expreſſes the greateſt deference to your Honour.*

Having therefore conſulted my Duty, as well as my Intereſt in this thing, I hope there is no one will think my addreſſes a rude tranſgreſſion of the Laws of Decency. I muſt confeſs, that theſe Diſcourſes are too mean, and unpoliſhed to deſerve your Lordſhips Patronage, but ſince the deſires of the Society *did incourage my deſign to publiſh them, this ſeems not only to make them capable of it, but to bleſs them with a Title to it. I do therefore preſume humbly to* *beg they may not offer themſelves to the World without the advantage of your Favour, which will render them more acceptable, and gratifie to the utmoſt the ambitious deſires of,*

My Lord,

Your Lordſhips moſt humble,

and moſt obedient Servant,

Clopton Havers.

To the moſt Worthy

Dr. *RICHARD MORTON*,

FELLOW

OF THE

Colledge of Phyſicians.

SIR,

I Have been a long time obliged by a continued ſeries of your Favours, and ſuch as would naturally, and irreſiſtibly ſuggeſt the thoughts of gratitude to any one, that has not debauched thoſe Principles of Reaſon, and Juſtice, which are common to all Men; and I cannot with any ſatisfaction live involved in ſo great a Debt without an attempt to make ſome grateful returns. And when I have this opportunity to make a publick acknowledgment of thoſe Obligations, by which I have plainly loſt the Title I had to my ſelf, and come under your commands, I dare not be guilty of that ſilence, by which I muſt ſeem either inſenſible, and no Man, or ungrateful, and the worſt of Men. I muſt own it as one of the kindeſt Providences of Heaven, that I had the happineſs, Sir, not only to be directed in my Studies by you, but by your particular favour to injoy many other great, and extraordinary advantages, to all which under the Almighty God I owe what I may pretend to in Phyſick. I do therefore as an expreſſion of that Reſpect, and Gratitude, which are due from me, humbly preſent you with theſe Diſcourſes, and although I ſhall never be able to ſatisfie that Debt, which I have contracted, yet this will be a demonſtration of my inclinations to be Juſt, and Grateful. And there is no one can be inſenſible, how far I I am in Juſtice bound to render to you that, which is an account of the Talent, which you, Sir, have intruſted me with, and ſo far as I am capable taught me to improve.

What entertainment theſe Diſcourſes will find in the World I know not. I cannot have ſo fooliſh an opinion of my ſelf, or them, as to think they are free from thoſe imperfections, which will betray the weakneſs of their Author, aud perhaps there are ſome things, which Candor it ſelf cannot overlook. However the ſecurity I ſhall have from your Patronage, gives me the proſpect of a more kind, and candid reception, than they can deſerve. Which I muſt ingenuouſly acknowledg carries ſo much of an Obligation in it, that whilſt I am endeavouring to diſcharge one Duty, I am ſenſible I contract a freſh Debt. Thus in the very expreſſions of my Devotion to your ſervice I meet with Arguments, which confirm my reſolutions to be,

Sir,

Your moſt humble,

and faithful Servant,

Clopton Havers.

The

THE INDEX.

The firſt Diſcourſe of the *Membrane*, the Nature, Conſtituent Parts, and Internal Structure of the Bones. Read *Aug. 7.* and *Octob. 23.* 1689.

THE Introduction Pag. 1
Of the manner of Generation p. 6
Of the Perioſteum p. 14
Of the Deſign of the Perioſteum p. 25
Of the Nature of the Bones p. 30
Of the Conſtituent parts of a Bone p. 31
Of two ſorts of Pores formed in the Bones for the diſpenſation of the Medullary *Oil to their Subſtance* p. 43
Of the Superficies of the Bones p. 49
Of the Pores of the Os Frontis, &c. p. 52
Of the paſſages of the Medullary *Veſſels into the Cavities of the Bones* p. 57
Of the large Cavities, and Latice work of the Bones p. 60

Of

Of the ſmaller Cavities of the Bones p. 71
Of the Blood Veſſels of the Bones p. 74
Some obſervations of the Teeth p. 78

The Second Diſcourſe of *Accretion*, and *Nutrition.* Read *Octob.* 30. and *Nov.* 13. 1689.

OF Accretion p. 91
Of Glandular Secretion p. 99
Of the general agreement of the Glands, *or thoſe Colatory Organs, which conſiſt of many ſmall* Glandules, *and ſerve for the ſeparation of any matter from the Maſs of Blood* p. 100
The manner of Glandular Secretion p. 109
Of the Nutritious Glandules p. 112
Of the manner of Accretion p. 117
Of the limitation of an Animals growth p. 126
Of Nutrition p. 133
Of the Accretion, *and* Nutrition *particularly of the Bones* p. 142
Of the Incurvation of the Bones in the Rickets p. 148
Of the knottineſs of the ends of ſome of the Bones in the Rickets p. 156
Of the Nodes *in the Bones from the* Lues Venerea p. 157

The Third Diſcourſe of the *Marrow.* Read *January* 29. 1689.

Of the Medullary *Blood-Veſſels* p. 162
Of the Membrane *of the Marrow* p. 163
Of the Bags, *and* Veſicles *or* Glandules *of the Marrow* p. 166
The paſſages of the Medullary *Oil into the* Interſtices *of the Joynts* p. 172
Of the different colour, and conſiſtence of ſeveral parts of the Marrow p. 175
Of the Uſe of the Marrow, or Medull. *Oil* p. 178

The Fourth Diſcourſe of the *Mucilaginous Glands.* Read *Nov.* 20. and 27. 1689.

Of the Mucilaginous Glands *of the Joynts* p. 187
The Sorts of them p. 190
Of the Structure, and particular ſituation of them, which are conſiderable p. 192
Of the Mucilaginous Glands *ſerving to the Muſcles, and Tendons* p. 199
Of the Nature, and Uſe of the Mucilage p. 201
The uſe of the Fat, which is ſeparated amongſt the Muſcles, and the reaſon, why it is waſted upon continued, and hard labour, or exerciſe p. 205

Of the manner, how the Mucilage is made, and of the uſe of the Spleen p. 210
Several Experiments made with the Mucil. p. 217
Of a Rheumatiſm p. 223
Some general Rules in the Cure of a Rheumatiſm p. 242
Of the Gout p. 249
The manner how the Tophi *are produced in a Nodoſe Gout* p. 262

The Fifth Diſcourſe of the *Cartilages.*
Read *Auguſt* 13. 1690.

OF the nature, and flexibility of the Cartilages p. 270
The reaſon of their flexibility explained p. 271
The cauſe of their reſtitution, or endeavour to return to their natural figure when they are bent. 274
The difference between a Bone and a Cartilage p. 279
Of the Membrane of the Cartilages p. 280
Of their Blood-Veſſels p. 282
Of the uſe of the Cartilages belonging to the true Ribs p. 284
How they contribute to the enlargement of the Cavity of the Thorax *in Inſpiration* p. 288
How they conſpire in the Contraction of the Breaſ in expiration p. 291

Th

TAB: II.

Fig: 3.

Represents the Figure of the particles, and the order, in wᶜʰ they ly in the Cartilages, and other flexible Bodys, that have a Rigidity.

The Mucilaginous gland, in one of yᵉ Sinuses of the os Humeri at yᵉ flexure of the Cubit, taken out of a Human Body

Fig: 1.

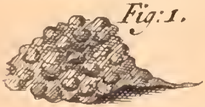


Fig: 4.

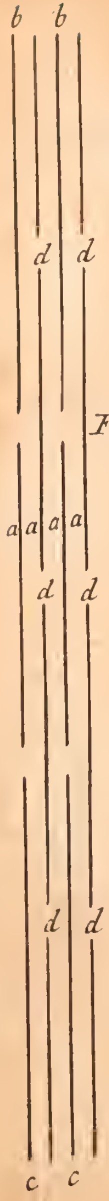
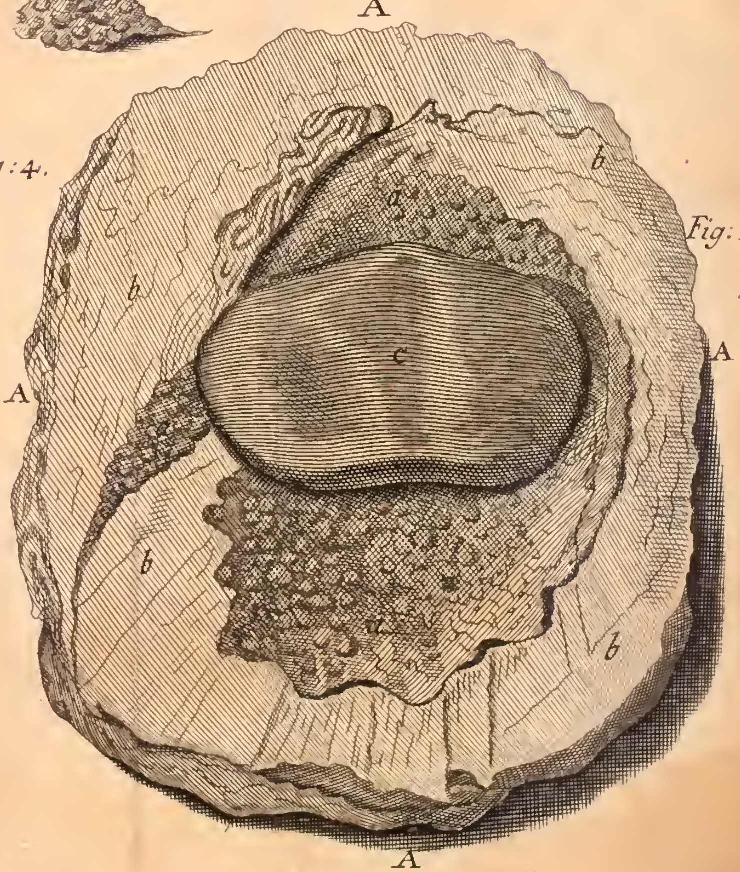


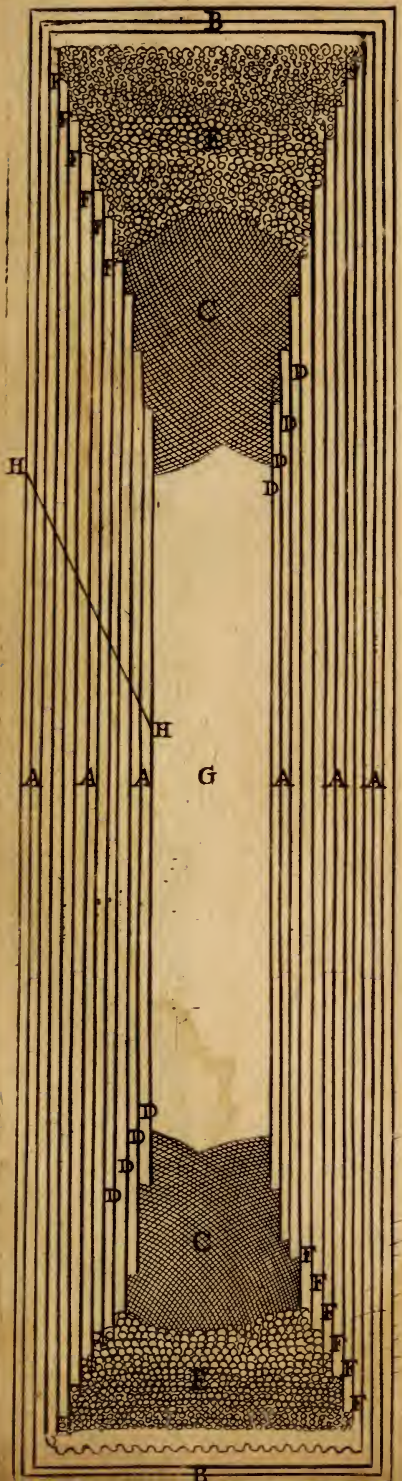
Fig: 2.



A·A·A·A· *The fore part of the Knee taken off.*
a·a·a. *The large Mucilaginous Glands*
b·b·b·b. *The Membrane which lyes immediatly over the Interstice of yᵉ Ioynt*
c. *The Patella.*

TAB: I.

Fig: 1



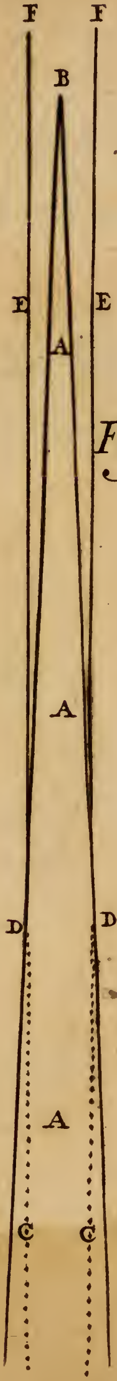


Fig: 2.

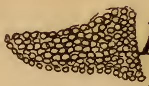


Fig: 3.

One of th
Bags of the
Marrow co
sisting of th
Small Vesicle
or Glandule

LIBRARY ... Mc
UNIVERSITY OF MARYLAND
1813
SCHOOL OF MEDICINE

The FIRST
DISCOURSE
Concerning the
MEMBRANE,
THE
NATURE,
Conſtituent Parts,
AND
INTERNAL STRUCTURE
Of the
BONES.

INTRODUCTION.

AS no Faculty has received greater Additions to its Improvement in this laſt Age than Phyſick, ſo no part of that has been more tempting, or more ſucceſsfully purſued than Anatomy. The Diſſections of many preceding Ages turn'd to a ſmall account;

ſo that many of the moſt admirable Contrivances of Nature, and of the greateſt Wonders in the leſſer World were inobſerv'd, till the Curioſity of ſome ingenious Men, animated with the hopes of ſome new Diſcoveries, put them upon farther Enquiries, in which their Induſtry, and Felicity carried them ſo far, that the Exiſtence of ſome parts before unknown, the Nature, Structure, and Uſe of others began to appear. But although the Scrutiny, and Obſervations of our Age about ſome of the Parts have been very accurate, we have been only coaſting about others; particularly, about the internal Fabrick, and ſome other things of the Bones, our Searches have been careleſs, our Notice ſlight and tranſient; not but that they deſerve our ſtricteſt Enquiry, and ſerious Remarks: for I do not ſee, but the Almighty Architect has equally demonſtrated his Divine Skill in the whole ſtructure of theſe Parts, which he has made of groſſer Matter, as in the Formation of thoſe, which conſiſt of ſifted, and more refined Particles. And how curious the Hand of Heaven has been in the Framing, and Ordering of this Timber-work of our Bodies, may perhaps appear a little from this Diſcourſe; a little, I ſay, becauſe I am too ſenſible, that after all my endeavours to act both the Philoſopher, and the Anatomiſt, I am infinitely unjuſt to my Argument; however, what I have obſerv'd, *obſerv'd, it is both my Duty, and my preſent Deſign to communicate to this Honorable Society; and as there are ſeveral things will occur, which deſerve and require a Philoſophical Solution, ſo I ſhall endeavour to account for them, by explaining the manner, in which they are produced, or conſidering the Reaſons, why Nature has ordain'd them, as I ſhall have occaſion.*

In ſpeaking to this Argument, I ſhall purpoſely omit the notice of the different Figures of the Bones, the diverſe manner of their Conjunction, and what has been commonly obſerv'd; and that I may preſent you with a Scheme of thoſe general Heads, which I deſign to treat of, they ſhall be theſe which follow:

Firſt, The Perioſteum, *or that Membrane, which inveſts the Bones, which being inſervient to ſeveral ends, I ſhall conſider the Uſe of.*

Secondly, The Bones themſelves, *where I ſhall endeavour to give an account of their Nature, their Conſtituent Parts, Internal Structure, and the Pores, and Paſſages, which are formed in them; as alſo of thoſe Blood-Veſſels, which ſerve for their Accretion, and Nutrition: And as the Teeth are a ſort of Bones different from* *all others, I ſhall add ſome particular Remarks concerning them.*

Thirdly, I intend to explain the manner how Accretion *and* Nutrition are performed, *firſt in general, and then particularly, with reſpect to thoſe Parts, which are our preſent Subject. And in treating of theſe great Affairs of Nature, I ſhall take occaſion to make ſome digreſſion about the manner of* Glandular Secretion, *concluding this Head with the Etiology of thoſe ſymptoms in the* Rickets, *wherein the Bones are concerned, and* Venereal Nodes.

Fourthly, I am to give an account of the Obſervations, which I have made of the Marrow, *and to deſcribe the* Blood-Veſſels *thereunto belonging, which when I have done, I deſign to conſider the Uſe of this Oleaginous Subſtance.*

Fifthly, I have a particular ſort of Glands *to give an account of, which I have obſerv'd in all the Joynts. I ſhall deſcribe the Structure, and Situation of the moſt conſiderable of them, and then enquire into the Nature, and Uſe of that Liquor, which is ſeparated by them. And becauſe the Obſervation of theſe Glands will be very ſerviceable to us in explaining the Cauſe of a Diſtemper, or two, that affect the Parts, in which*

which they are ſeated: I ſhall ſay ſomething concerning thoſe Diſtempers, which will be firſt a Rheumatiſm, *and ſecondly the* Gout.

Sixthly, and laſtly, I ſhall conclude my Diſcourſes with an account of the Cartilages; *explaining their Nature, deſcribing their Membrane, and their Structure, and enquiring into the Uſe, particularly of thoſe which are united to the true Ribs.*

The Manner of

GENERATION.

IT may perhaps be thought reaſonable, and methodical by ſome, to begin my Diſcourſe with the Original of my Argument, and to offer ſomething concerning the manner, how the parts, of which I am to Treat, are firſt formed, and although the manner of an Animal's formation, whether it be generated in the Womb, or out of it, is one of the great *Arcana's* of Nature, and that which neither our Senſes can obſerve, nor any thing of Art or Mechaniſm imitate; yet we may make our conjectures, and find out ſome probable, and rational Hypotheſis for our ſatisfaction.

The Antients for want of thoſe diſcoveries, which ſince their time have been made, had a Notion that the *Semen* of the Man was a part of the Conception: that the Woman had a true Seed, and a compoſition ariſing from the mixture of the Seed of the Male, and Female, was the material cauſe of the Bones, as of all other parts, which they termed Spermatick. But *de Graef* has better informed us, and taught us to explode that Opinion, ſo that it neither admits of a Defence, nor needs a Refutation, ſince he has diſcovered to us Neſts of Eggs in Viviparous Animals, and that in the Bellies of Women.

The Origine therefore even of the higheſt Animal being from an Egg, it may perhaps, if duly conſidered, ſeem moſt probable that the Bones, and all other parts are by the admirable Stenography of Divine Providence delineated in the Egg, whilſt it is in the *Ovarium*, and before the Female is impregnated. Neither can it ſeem improbable, that ſo many parts ſhould be deſcribed within the circumference of ſo ſmall a Body, when we conſider the minuteneſs of ſome Animalcula, and that notwithſtanding they conſiſt of Spirits, Humours, and a multiplicity of Organical parts. And if we ſuppoſe an analogy between theſe Eggs, and the Seeds of Plants, which it is reaſonable to do; the Obſervations which are to be made of the one, may direct us in our Hypotheſis concerning the other, and favours our Notion, when we ſee the Rudiments, the Leaves, the Stem, and Radicle of a Plant, are to be found in the Seed before it falls into the Womb of the Earth, and under the generating influences of the Heavens. It is true the parts of an Animal, whilſt they ly within the compaſs of an Egg, are indiſtinguiſhable unto us, and muſt neceſſarily be ſo until, and for ſome time after the Vivifick Spirit of the *Semen* has put the fluid, and volatile Particles into motion, after the firſt, and efficacious impreſſions of which the affair of Generation ſeems to be carried on in this manner: to wit the Particles, which are the firſt Principles of the Humours, and all thoſe, which are diſpoſed for an activity, being by this motion put into a Fermentation, are rarifyed, and expanded, and thereupon requiring a larger ſpace, than that, which was capable of containing them, whilſt they were more quiet, and by Nature diſpoſed in ſuch an order, as to ly within thoſe bounds, which the convenient magnitude of the Egg could not allow them to exceed before an Impregnation, they begin to dilate the Cavities, and Veſſels, which contain them. Being put into motion, though at firſt it be languid, and proportionate to the tone of thoſe parts, which are afterwards ſolid, they naturally endeavour to perſiſt in it. And although their firſt, and natural tendency, after they are moved, cannot be thought to be the ſame in all the parts, that are thus agitated, yet by the contraction, and pulſe of the Heart, it comes to be directed in all of them to the ſame general *terminus ad quem*, that is the Veins. For whether this Fermentation be excited in all thoſe Particles at the ſame time, which afterwards appear in the form of a Humour, or are exalted into Spirits; or be firſt begun in the *Punctum ſaliens*, or that which is afterwards the great Elater of the Blood, the Heart, 'twill come to the ſame thing.

If the Fermentation be excited in all that matter contained in the Ventricles of the Heart, and all the Arterial Channels at the ſame time, though there follows a great variety in the tendency of the motion of theſe Particles, ſo that ſome fly one way, at leaſt endeavour it, and others another, yet ſtill the Heart has the aſcendant over all of them, ſo that the pulſe of this Machine, and the power and motion of thoſe Particles, which are immediately propelled by it, direct the courſe, and order the tendency of all the reſt, ſo that at laſt they come to be all moving towards the extremities of the Arteries, and to the Veins, which ſucceed to them.

If we ſuppoſe the Fermentation in the beginning to be partial, and excited only in that matter, which lies within the Cavities of the Heart; as I am apt to think, that the Veſſel, which afterwards appears to be the Umbilical Vein, has its courſe always towards, and terminates in the Membrane of the *Ovarium*, where there is a Pore, by which the ſpirituous Vapour, or fermentative Particles of the Seed entring the ſmall duct, is conveyed to the Heart, and that to both Ventricles in a manner at the ſame time; ſo that whilſt one part of them actuates that matter, which lay in the right Ventricle, the other with their full vigor and vertue, communicate a motion to that, which is contained in the left: and to this end Nature ſeems to have formed the *Foramen Ovale* in a *Fœtus*, by which there is a paſſage from the *Vena Cava*, into the *Vena Pulmonaris*, and ſo into the left Ventricle, without ever coming into the right, that ſome part of the Seminal Spirit may be immediately diſpenſed to the left Ventricle, and agitate the Particles contained in it, before it has ſpent, or weakened its force by acting upon other matter. I ſay if the Fermentation be thus partial, we may conceive how the Particles in both Ventricles being rarifyed, and expanded, dilate them, and oblige the Fibres of the Heart to a renitency, and contraction, and ſo give them the occaſion of beginning to make a Pulſe, by which contraction, and the expulſion of ſome part of that matter, which was lodged within the Cavities, they not only communicate a motion ſucceſſively to thoſe parts, which are contained in the *Aorta*, and all the Veſſels, which are propagated from it, but direct and determine their motion towards the Veins; and thus the fluid parts begin their Circulation. And as by the motion and expanſion of theſe Particles the Arteries are diſtended; ſo partly by this expanſion, partly by the more direct preſſure of that matter, which is in Circulation, the extremities of theſe Veſſels, and the paſſages into the Veins, which begin where they terminate, will be opened, and ſo the circulatory courſe of the Blood will be continued into the venoſe Channels. And becauſe the putting the Blood into a due, and certain courſe of Circulation is a buſineſs of great importance, abſolutely neceſſary to the Life, and regular encreaſe of the *Fœtus*, as well as in the whole courſe of our lives after the Birth; therefore there ſeems to be a particular contrivance for the more effectual accompliſhing of this deſign in the *Canalis Arterioſus*, by which the Blood, that after the *Fœtus* is excluded, is driven out of one Ventricle into the other through the Lungs, at this time paſſes directly out of the right into the *Aorta*, and this Ventricle, which after the Birth neither adds to, nor determines the motion of the Blood in the great Artery, does evidently, whilſt the *Fœtus* is in the Womb conſpire with the left in the agitation of that matter, which is in the *Aorta*, and by the mediation of the Particles, which it immediately propels, makes a preſſure upon it to drive it on in the Arterial Channels, as well as the left Ventricle does. The reaſon why the courſe of the Blood is diverted from the Lungs, I know, is commonly ſuppoſed to be, becauſe the *Fœtus* does not reſpire in the Womb. But this does not ſeem to me a ſufficient reaſon; for though it is not neceſſary that the Blood ſhould Circulate through the Lungs, upon the account of reſpiration, yet I do not ſee it would be either impoſſible, or inconvenient for it to have its courſe through them, before the *Fœtus* is excluded, and comes to breath. There are the ſame paſſages or Pneumonick Veſſels before, as after the Birth. And what though the Lungs do always ſubſide, do they not the ſame in expiration? Nay does not the paſſage through theſe Veſſels ſeem more free and eaſie, whilſt the Lungs ſubſide, than when they are inflated, and all the *Bronchia*, and Veſicles diſtended, at which time the Blood-Veſſels muſt neceſſarily be more compreſt and ſtreightned? But ſuppoſing the Blood could not have a free paſſage through the Lungs of a *Fœtus*, and the defect of reſpiration forbad it; yet this is no reaſon, why the right Ventricle ſhould propel the matter it contains, into the *Aorta*, and not throw it into the left by ſome contrivance like the *Foramen Ovale.* So that we may reaſonably think there was this deſign, to bring both Ventricles into a Conſpiracy to determine the motion of the Particles, which are yet to be ſettled in a due courſe, to the Veins, and to drive them on through all the Stages of Circulation.

In the ſame manner, as the extremities of the Arteries are opened, that is both by the expanſion, and direct preſſure of the Particles, which move in them, the Pores of the Glandules, whether ſeated in the ſides, or at the extremities of the Arterial Channe's, which before were cloſed, will be dilated, whereby they become fit for, and begin to perform ſecretions, then are the Spirits ſeparated by the Brain, and when this habitation of the Soul is furniſhed, and as ſoon as a ſufficient quantity of Spirits are ſupplyed to irradiate the *Syſtema Nervoſum,* then may probably be the time, when the Soul of a humane *Fœtus* is infuſed, and takes poſſeſſion. The Nutritious Glandules amongſt others beginning to perform their Office, do give the Bones, and all the ſolid parts a continual ſupply of ſuch Particles, as are of their own nature, and fit to be apponed to them, whereby they increaſe, and as the vigor, and preſſure of the Spirits grows ſtronger, and as it were knocks theſe Particles nearer to one another, the parts begin to ſhew ſome ſolidity, to diſcover their nature, and become viſibly diſtinct. And this Hypotheſis, how ſtrange ſo ever it may ſeem to ſome, does give us a clearer, and more intelligible Notion of the manner of Generation, and the effects of the *Semen* upon the Egg, than what has been ſaid of that plaſtick power, which has been ſuppoſed to be in the Seed of the Male, and to form the parts of an Animal from a rude and indigeſted *Chaos.* But I paſs off from theſe conjectures to the conſideration of that Subject, I have propoſed to Treat of, which does in many things offer it ſelf to our Senſes, and encourages us with fairer promiſes of certainty, and ſatisfaction, and I begin with that part, which firſt preſents it ſelf to our view, and obſervation, the *Perioſteum.*

Of the PERIOSTEUM.

THIS is a thin tranſparent Membrane, made up of moſt minute, and curious threads, endued with an acute ſenſe, and expanded over the Bones. The Fibres, of which it conſiſts, are not interwoven one within another, but diſpoſed in ſeveral Series one over the other. It is in ſome parts thicker than in others, and conſequently leſs tranſparent. In ſome places it offers its ſuperficies fairly to our view, that is where no Muſcles have their origination, nor are immediately inſerted by their Tendons, (though it is true every where elſe there are ſome Filaments inſerted into it from the Membrane of the Muſcles) and where it may be obſerved, though it is not exactly ſmooth, it is more equal, than on that ſide, which lies next to the Bone; for on this part it has every where inequalities, ſome whereof are in the form of ridges, others are ſmall Protuberances of divers other figures, ſome round like little Mole-hills, ſome Oval, &c. to ſpeak briefly of which, they are correſpondent to ſome ſuperficial Cavities formed upon the Bones, which I ſhall afterwards have occaſion to ſpeak of. It has Blood-Veſſels, both Veins and Arteries, which are viſible enough in the *Perioſteum* of large Beaſts, but they have nothing particular, that is worthy of our remark.

About the Origine of this Membrane, I do not find that Anatomical Authors ſeem much to concern themſelves, not ſo much as generally they do about that of the *Pleura*, and *Peritonæum*. The account, that may be gathered from ſome few of them, is, that the *Perioſteum* of the Skull is from the *Dura Mater*, and that of other Bones from the Fibres of the

Muſcles. But ſince it is a Membrane common to the Bones, it does not ſeem ſo reaſonable to ſuppoſe, that in one place it has an original ſo different from it ſelf in another, eſpecially conſidering that there are Muſcles about the Head, as well as in other parts, from which it might be produced. And the beſt account of it, that I could gather from a ſtrict examination of this Membrane, is, that the Fibres which conſtitute it, are every where of two ſorts, ſome of them are propagated from the *Dura Mater*,* others from the Fibres of the Muſcles. That the *Perioſteum* of the Skull, which lies next to the *Cranium*, is derived from the Brain, appears not only from what has been commonly obſerv'd, that they are united, and the one continued from the other through the Sutures in a *Fœtus*, and Infants newly born; but beſides this, the *Dura Mater* paſſes out of the Skull at other places, as between the *Os Sphœnoides*, and the *Os Petroſum*, ſo between the *Os Petroſum* and the *Os Occipitis*, which is the reaſon why it adheres ſo firmly to that part of the *Cranium*. When it is got out beyond the Bones, between which it is double, it ſpreads its ſelf both ways over the Bones, one part running one way, and the other another. And as the *Pericranium*, which I cannot conceive to be any other than the *Perioſteum* of the Skull, owes the original of one Series of its Fibres to the

* And whence does the Dura mater originate?

Dura Mater, ſo does the *Perioſteum* in all other parts; therefore in that part of this Membrane, which lies next to the Bone, there are every where a Set of Fibres, whoſe tendency is direct from one end of the Bone towards the other, and without that Variety in their Poſition, which is often to be obſerved in thoſe Threads, which are deriv'd from the Muſcles. This may ſeem improbable; for though we may eaſily conceive how thoſe Filaments, which are propagated from the *Dura Mater*, may be continued from one Bone to another in the *Pericranium*, ſo far as the Bones are joyned by Sutures, or Harmony; yet where the Bones are articulated, and diſtinguiſh'd by viſible Interſtices, and when the Membrane, which lies over thoſe Interſtices, is no part or continuation of the *Perioſteum*, the courſe of thoſe Fibres, which proceed from the outward Membrane of the Brain, muſt be interrupted, and after their termination, the *Perioſteum* muſt neceſſarily be wholly deriv'd from ſomething elſe. But this difficulty I ſoon got over, when I came ſtrictly to examin the Ligaments of the Bones, where I obſerved a continuation of theſe Threads running upon thoſe Ligaments, by which means they proceed from one articulated Bone to another.

Beſides the Filaments, which ariſe from the *Dura Mater*, and make that part of the *Perioſteum*, which lies next to the Bone, there are another Set of Fibres, which are propagated from the Muſcles, and Tendons, which accede to it in every part as it proceeds; The Original of theſe in ſome parts, eſpecially upon the Bones of large Animals, is eaſie to be diſcover'd; for by taking one of the exterior Fibres of a Muſcle, and ſeparating of it gently, it not only leads us to the *Perioſteum*, but I have trac'd ſome of them a good way upon this Membrane, where its ſuperficies has been clear of the fleſhy Fibres.

The order, and courſe of the Fibres in this Membrane, is not the ſame in all of them: Thoſe indeed, which are propagated from the *Dura Mater*, are every where parallel, and their Tendency, as I have already obſerv'd, is from one end of the Bone to the other: But for them, which are deriv'd from the muſcular, or tendinous Fibres, they are not conſtantly agreeable in their courſe and poſition, but as they differ ſometimes from thoſe, which proceed from the *Dura Mater*, ſo thoſe, which are propagated from one Muſcle, have in ſome places a tendency different from them, which are deriv'd from another; ſo that I have in the *Perioſteum* of one of the Bones of the Leg, obſerved three ſeveral ſeries of Fibres lying one over another; the interior, or thoſe next the Bone were ſtreight, the reſt ariſing from two ſeveral Muſcles, whoſe different ſituation gave their Fibres in their elongation a different tendency; thoſe that were derived from one Muſcle, proceeded obliquely one way, and they that were from the other, obliquely the other; that they decuſſated one another in the ſame manner, as the Fibres of the obliquely deſcending, and aſcending Muſcles of the *Abdomen* do. And according to the poſition of the muſcular Fibres, with reſpect to thoſe Threads of the *Perioſteum*, which have their *Origine* from the *Dura Mater*, the Filaments, which are derived from thoſe Muſcles, are ſometimes parallel, in ſome places tranſverſe or oblique to them, which proceed from that Membrane of the Brain. Therefore I have in tearing of this Membrane of the Bones obſerved, that in ſome parts it has been more eaſily rent directly, that is where the Filaments were all parallel, and obſerved the ſame tendency; and in others, where ſome of them were oblique, or tranſverſe, it was not ſo very difficult to pull it aſunder that way.

However the Tendons of many Muſcles do propagate their Fibres to make ſome part of the *Perioſteum*; yet, I have obſerved that ſome of them, which have often a great ſtreſs or dependence upon them, when they act, have not been ſo kind, but penetrated this Membrane, and were immediately inſerted into the Bone, ſo that I could diſtinguiſh the *Perioſteum,* which lay like a Circle round them; and this has given me an occaſion to think, that all thoſe Threads of the *Perioſteum,* which are propagated from the muſcular, or tendinous Fibres, after they have run ſo far as to make up their part of this Membrane, are inſerted into the Bone, and that they are particularly theſe, which as I ſhall hereafter ſhew, penetrate into it.

From the account that I have given of the *Perioſteum,* it may appear, how little reaſon we have to make the *Pericranium* a diſtinct Membrane from the *Perioſteum* of the Skull: For although it be divided at the temporal Muſcles; this is no more than what the ſeveral ſeries of Fibres do make the *Perioſteum* capable of in the Leg, or any other part; and I have upon the Shin-bone of an Ox divided it into four or five ſeveral Membranes, if I may ſo call them, when it has been dry'd.

The Adheſion of the *Perioſteum* to the Bone is firm, and intimate, partly by contiguity, partly by continuity, or the inſertion of ſome of the Filaments of the *Perioſteum* into it, and by the Blood-Veſſels, which are propagated out of one, and ramified in the other, and like ſo many ſmall Ligaments hold them together.

By contiguous Adheſion I mean that union, which ariſes from the immediate Coadjacence or Contact of two Bodies of a fixed Nature, where no matter either Volatile, or Elaſtick intervenes, ſo as to concur with that force, which endeavours to ſeparate them, and is a manner of Conjunction, which ſome Experiments, that I need not here mention, do demonſtrate to us. That part of the *Perioſteum*, which is thus united to the Bone muſt be the Fibres, which are propagated from the *Dura Mater*, as being thoſe, which lie next to it. To add to the ſtrength of this part of their union Nature has wiſely contriv'd; for all Adheſion, and Union of this kind being ſo much the more firm, as the Superficies is larger, in which the two Bodies, that are contiguous, do touch one another, the Surface both of the Bones, and their Membrane on that ſide, which is next to them, is ſo formed as to receive a conſiderable enlargement by inciſions, and ſmall ſuperficial Cavities formed on the outſide of the Bone, and by ridges, and other protuberances on that ſide of the *Perioſteum*, which is immediately applyed to it. And I need not ſtand to ſhew how theſe inequalities enlarge their ſuperficies beyond what it would be, if it were ſmooth and plain, ſince it is evident.

But to explain this Adheſion of the *Perioſteum* by ſomething, that is more familiar, and a Notion more intelligible, I conceive that the Bones obtain very much the nature of a Gluten. When their Generation has proceeded ſo far, that they have made ſome advancement towards their natural Temper, they are like melted Glue, to which the *Perioſteum* being applyed, whilſt they are ſoft and viſcous, does adhere, though not ſo firmly at firſt, but as this Glue, I mean the Bones are indurated, and their parts more fixt, the union between them, and their Membrane is more and more confirmed, until at laſt they are not eaſily ſeparable. And as the *Perioſteum* at firſt cleaves to the Bone, whilſt it is ſoft, ſo afterwards in all the growth of it, that matter, which gives an increaſe to the Bones being, when it is firſt ſupplyed and apponed to them, viſcous like the ſubſtance of a new formed Bone, is as apt to ſtick to any addition made to the *Perioſteum* in its growth, as the Bone it ſelf was to cleave to its Membrane at its firſt Formation. Neither is this Notion of the Adheſion of the *Perioſteum* to the Bone in ſuch a manner, as if they were joyned by Glue merely conjectural, but grounded upon a ſmall Experiment I made: I took a piece of a freſh Bone, and diſſolved it in *Aqua Fortis*, then I ſet it over the Fire in a glazed Veſſel, and evaporated ſo much of the liquid part, that I reduc'd the Solution near to the conſiſtence of a Jelly, then I ſet it to cool; after it was cold, it not only reſumed its hardneſs, (though it was more brittle) but adhered to the Veſſel as intimately, and firmly as ever I have obſerved Glue it ſelf to do to a Veſſel of the ſame kind. Beſides, the Bones in a *Fœtus* are plainly gelatinous, and viſcous at one time, and in a Calf, which I had taken out of a Cow ſometime before it was to be excluded, where the greateſt part of the Bone was in ſome meaſure indurated, I obſerved ſuch a gelatinous matter between that part, which was more ſolid, and the *Perioſteum.*

Beſides this manner of Adheſion, the *Perioſteum* is united to the Bone by little *Fibrillæ* or Threads continued from the one, and penetrating into the ſubſtance of the other, which may be obſerved in a perfect Bone, eſpecially in ſome places. But I diſcovered it more plainly in the Bones of a Calf, which were tender and imperfect, where I found the Threads penetrating that gelatinous Matter, which lay under the *Perioſteum*, and beyond it were inſerted into that part, which was indurated, out of which I could draw ſome of them.

By theſe Fibres, and the mediation of the *Perioſteum*, it is probable that the Bones have ſome internal ſenſe, ſo that they may be ſaid to be ſenſible not only in their Membrane, but even in their ſubſtance. When we conſider how the Teeth, which are at leaſt in the ſtony Cortex of that part, which ſtands out of the Gums, more ſolid than any other Bones, will be affected by injuries, which make no immediate impreſſion upon the Nerve, which lies in their Cavities, as to inſtance only in that particular ſort of ſenſe they have upon the application of Acids, when their *Mucus* is ſcoured off, which we term ſetting them on edge, what is this but a ſenſibility of Bones? Conſidering that this ſenſe muſt be by the *Fibrillæ* of the Nerve inſerted into them, that theſe Nerves anſwer for the defect of the *Perioſteum* in that part of every Tooth, which ſtands out of the Gums; and that this ſenſible Membrane does propagate Threads into all the Bones, how can we think but that any irregular, and tumultuous motion in the Spirits of theſe ſolid parts is communicable to the Brain by the mediation of thoſe Fibres, which are derived from the *Perioſteum* into any Bone, as well as by the Nervous Fibres, which are diſperſt in the ſubſtance of the Teeth. And to confirm what I now ſay, there is an obſervation of *Nicolaus Maſſa*, which *Diemerbroek* mentions, of a Man, that had an ulcerated Leg, where the Bone, which was deprived of its Membrane, was ſo ſenſible, that it could not be toucht without pain; nay, the Bone was Perforated, and he found it had a ſenſe in the internal part, which gave him the ſuſpicion of Nerves, but he has left it to others to find them, and as I could never with the ſtricteſt enquiry obſerve any ſuch thing, ſo I have ſhewn how the want of Nerves is ſupplyed, and we may be able to account for the ſenſibility of the Bones without their proper Nerves.

I come now to conſider the Deſign and Uſe of the *Perioſteum*; and firſt, it is to be a Tegument to the Bones: for Nature in the Formation of all the parts is found to be Elegant, as well as Provident, and though it could be granted, that this Membrane ſerves to no neceſſary uſe, yet it is for decency.

Secondly, It conveys Spirits into the ſubſtance of the Bones for maintaining their Heat, for preſerving their Senſibility, and to aſſiſt in the Work of their Accretion, and Nutrition. How this Membrane immits minute Fibres into the Bones I have already obſerved, and I do ſuppoſe they are continued ſo far as to be *Infundibula*, and diſembogue themſelves into the Interſtices of the bony Strings, in which the Spirits afterwards move as their Channels, and therefore ſome of theſe Fibres inſinuate themſelves farther into the Bone than others, as the Interſtices which they ſerve to, are more remote from, or nearer to the Superficies.

Thirdly, It ſeems to be one thing, which checks, and helps to ſet limits to the growth, and extenſion of the Bones. Whilſt this Membrane is growing, and capable of being farther expanded, ſo long it allows the Bones the liberty of inlarging their dimenſions, but when it ceaſes to be extended, and cannot admit of their increaſe without a rupture, then there is ſome ſtop put to their growth. Therefore we ſhall find, that the *Perioſteum* is ſtretcht upon the Bone to its utmoſt extent, ſo that when it is divided in any part either directly, or tranſverſly, and raiſed from the Bone, it is ſo ſtreight, and correſpondent to that part, which it was applyed to, that the *Labia,* where it is divided, cannot fairly, and without tearing of it, be extended ſo as to be brought to lie one over the other. Neither will it ſeem improbable that ſo thin a Membrane ſhould hinder the increaſe of the Bones, if we conſider the ſtrength of it, and how we have inſtances that ſeem very like it in Trees, where the

Bark is often obſerved to bind them when they are young, ſo that it is neceſſary to open it before they can have the liberty of thriving. And even amongſt Animals it is not unknown how the Skin of a Horſe, which is naturally more Tenſile, when he is Hidebound, as they term it, checks and hinders his growing. Not that I think this is the only, or principal thing, that determines the meaſure of the Bones Accretion, I only ſuppoſe it conſpires with another Cauſe, which I ſhall explain, when I come to ſpeak of Accretion, and to ſhew the reaſon, why it ceaſes in full grown Animals.

Fourthly, The *Perioſteum* is ſerviceable in the Conjunction of the Bones and their Epiphyſes, whilſt the ſubſtance of the Epiphyſes is cartilaginous; of thoſe Bones, which are joyned by Sutures or Harmony, and in the connexion of the Bones and their Cartilages. For being a ſtrong Membrane, and firmly adhering to any of theſe parts, which are to be united, and not being Tenſile like ſome other Membranes, it does not ſuffer them eaſily to recede from each other, or to be diſplaced, which cannot be without a diſruption, or a diſengagement from one of thoſe two parts, which it holds together. This, though it be not the ſame thing as the continuation of the ſame Body; yet it does in a great meaſure anſwer to it, and is a manner of Conjunction, which Art does often imitate. And I not only ſuppoſe this to be one uſe of the *Perioſteum*, but it is very evident where the Cartilages are joyned to any Bones; for if we take the *Scapula*, or any of the Ribs, and divide this Membrane round that part, where their Cartilage is united to them, though there is another contrivance for their Conjunction; yet they will be eaſily ſeparated.

Fifthly, It ſerves for another conſiderable deſign, and that is to joyn the Heads, and Tendons of the Muſcles faſt to the Bones: for although, as I have already obſerved, the Tendons of ſome Muſcles do penetrate this Membrane directly, and are immediately inſerted into the Bone; yet the Origination, and Tendons of a great many Muſcles have their immediate dependence upon the *Perioſteum*, by whoſe mediation they are faſtned to the Bone. And for this Reaſon it ſeems to be, that Nature has made the Adheſion of of this Membrane to the Bone ſo firm by that contrivance, which I have taken notice of.

Sixthly, and laſtly, If the ſenſe that this Membrane is endued with, was intended with a particular reſpect to the Bones themſelves, as it ſeems to be, and not merely a Conſequence, as the *Perioſteum* is propagated from ſuch parts, as are acutely ſenſible, it was deſigned for the ſafety, and ſecurity of the Bones from external injuries, for the diſcovering to us the part affected, when they are diſtempered, and directing us in the application of external Remedies. As for other inconveniencies and injuries, which follow upon any external violence, excepting the pain, which they threaten, they are not ſo ſuddenly thought of, but this evil of pain we have a natural, and an immediate abhorrence of, without any deliberate thought or conſideration, and as the apprehenſions of it, ſo our endeavors to prevent it are quick, and as this obliges us to watch over them; ſo it makes us withdraw them haſtily from any ſudden dangers, or appearance of Miſchief. Thus for the ſecurity of the Eye, which in the *Tunica Cornea*, has no ſenſe; Nature has given it one, which is acutely ſenſible, and the deſign certainly is that the pain, which the *Tunica adnata* is obnoxious to, ſhould give us the occaſion of ſhutting our Eyes againſt any thing that may excite it, and conſequently ſerve for the ſecurity of the whole Eye: And thus much of the *Perioſteum*.

Of the Nature, and Conſtituent Parts of the BONES.

NOW I have laid aſide the *Perioſteum*, the next thing, which comes in view, and under our examination, is the Bone it ſelf, and I ſhall enquire

Firſt, Into the Nature of the Bones, which like other products of Nature have their infancy, or firſt beginning, their improvement, and tendency to maturity, and their perfection. At their firſt beginning they are ſoft and gelatinous, that is, whilſt their proper parts not only are diſunited, but have a mixture of ſuch moiſt and looſe Particles, which intervene, as are neither apt themſelves to be fixt, nor will ſuffer thoſe, which are fit to make a Bone, to unite, as we ſee water inſinuating it ſelf between the Particles of *Gum Arabick*, or any Body of that Nature deſtroys its hardneſs, and rigidity, and renders it ſoft and gelatinous. When they advance near the temper of a Bone they are cartilaginous; as thoſe Particles, which are fit to make a Bone, are driven nearer to one another by the power of the Spirits, and the preſſure of that Nutritious Juice, which they drive to, and crowd againſt them, they expreſs, and begin to free themſelves from thoſe parts, which lay between them, and hindered their mutual acceſs, and that unition, which was requiſite to make a ſolid Body of them; but ſtill theſe Particles are not united at their extremities, which makes the parts, which they conſtitute, remain as yet leſs ſolid, and more flexible than a perfect Bone. But when the Bones are grown to that perfection to obtain their proper Nature, they are ſolid, and conſiſt wholly of Parts, which are naturally fixed, and void of motion, which being united, do all Conſpire to reſiſt a Preſſure, and any endeavours to diſturb, and diſunite them, ſo that they can neither be agitated by Subtle, and Volatile Particles within; nor be moved, and diſordered but by ſome great and extraordinary violence from without. Theſe parts are of two ſorts, to wit, Terreſtrial, and Saline. It is true, if we come to torture a Bone with the Fire, it ſeems to confeſs that it conſiſts of all the five Chymical Principles; it affords us a Spirit, and Phlegm, a Volatile Salt, and an Oily or Sulphureous Subſtance, in which there is the ſame difference to be obſerved as in the *Medulla*, one part is ſoft and liquid, the other is more indurated like a *Sebum*, and the hard part of the Marrow ; after theſe parts are abſtracted, we have the Earthy, and ſome fixt Saline parts remaining behind. But theſe ſeveral parts are found in a great diſproportion, the Terreſtrial only are, after a thorough and perfect Diſtillation, above two parts of three, which I take to be the trueſt account of their quantity. I have after a long Calcination of Human Bones, found them to be five parts of nine, but by the continuation of the Fire, they ſtill loſe of their weight, ſo that I could not here tell where to fix the quantity of them : The fixt Salt is very little, and indeed but juſt ſo much, as that we may ſay they have ſome. The Volatile Salt was about a thirtieth part : the Spirit, and Phlegm, are not ſo plentiful as in Harts-Horn, being about an eighth, whereas in Harts-Horn they are above a fourth part; the fluid Oil a twenty fourth, beſides a good quantity of that oily Matter, which was indurated, and ſtuck to the upper part, and ſides of the Retort. But to ſpeak truly, theſe cannot all be properly ſaid to be the parts of a Bone : the Spirits, and Phlegm, are drawn from the Blood-Veſſels, and the Interſtices of the bony Strings, in which the Spirits flow whilſt the Man is alive, and the Oil is plainly what had been ſupplyed from the *Medulla*, and inſinuated into the ſubſtance of the Bone by

Pores, which I ſhall hereafter deſcribe, ſo that none of all theſe can be ſaid to be the parts of a Bone any more, than the blood may be ſaid to be the part of a Vein, or an Artery. That which we call the Volatile Salt, at leaſt the greateſt part of it, I take to be a Conſtituent part of a Bone, and however it is raiſed, and brought over by the Fire; yet the Particles of it are ſolid, and fit to be one ingredient in theſe hard and rigid parts, in which whilſt they are lodged, they are fixt, as we find after Diſtillation they will be Chryſtallized, and reſume a ſolidity; beſides, this Salt does ſhew much of a fixed Nature upon the Tongue, when it is taſted, having ſuch a kind of ſenſible coldneſs as *Sal Prunellæ* has.

The Particles of which the Bones conſiſt, when we conſider how they form Strings, ſeem to be of a long Figure, and their poſition ſtreight, ſo that one end lies towards one, and the other towards the other extremity of a Bone in the ſides of it. I ſay in the ſides, becauſe where the Strings alter their courſe, and run Obliquely, or Tranſverſly, as in the *Cancelli,* and ſmall Caverns of the Bones, and at the extremities, where they lie over, and ſhut up the Cavities, the poſition of theſe Particles muſt be different. Perhaps I may ſeem to contradict my ſelf, when I ſay the bony Particles are of a long Figure, and yet make the Bones to conſiſt of two different Principles, which may be thought to be an implicite Aſſertion that their Particles are diverſly figurated. But it is very conſiſtent with the Notion, I have of the Particles of all at leaſt ſolid Bodies, which is, that none of them have the true and diſtinct Nature of any one pure Principle; but are a compoſition of two, or more, and from the proportion of the Principles, and the manner of their mixture or union, ariſe the Figure and Nature of the Particles, which they produce. So that though there is certainly a difference in the Figure of the Particles of every Principle; yet thoſe which are formed from the Union of two, or more of them, may all be a like figurated in a Body, which contains ſeveral Principles.

The bony Particles are in every Series united at their extremities, and by this Union they form continued Threads or Strings, which continuity gives the Bones a rigidity. The courſe or tendency of all theſe Strings in the ſides of a Bone, is as the poſition of the Particles, from one end towards the other, and wherever the *Laminæ,* which they make, are contiguous, they are Parallel, and ſo far ſtreight as the Figure of the Bone will admit. Their courſe is no where more eaſily to be diſcovered in the Bones either of Men, or Brutes, than in the Ribs, where ſome of them may be ſeparated, and run in the form of a String ſometimes for ſome way together. And if we ſuppoſe, as we muſt do, the Horns of Beaſts to be of the Nature of Bones, there are ſome of them, which plainly diſcover thus much to us, that the Bones conſiſt of ſeveral ſmall Strings, as particularly in the *Rhinoceros* Horns in the Repoſitory their Strings are actually divided, and their courſe viſible at their Baſis. Or if we may make a judgment of our own Bones, and thoſe of Birds and Beaſts by Animals of another Element, the Whale-bone does ſufficiently demonſtrate, both that they conſiſt of ſuch Strings, and that the courſe of them is from one end towards the other. In ſhort, in all the Bones, even thoſe, which are not to us diviſible into ſtringy parts, their tendency does evidently appear in the Fiſſures, which are many times to be obſerved in them, when they have lain in the Sun, or are any ways dryed ſo as to crack.

Theſe Strings, though ſome of them run to the very extremities of the Bones, and others approach near to them, do not terminate there, ſo as to have diſtinct ends, but they are, where they may be thought to terminate, ſtill continued, and run tranſverſly, and as it were Arched, that the Strings of one ſide of the Bone proceed ſo as to meet, and be united to thoſe, which are propagated from the oppoſite; and this at both extremities, that they are a continuation, though not of the Figure; yet in the manner of a Ring. Therefore they are not all of a length, but in every Plate they fall one ſhorter than another. Thoſe which make the external Plate run from one end quite up to the other, and are the full length of the Bone, and in ſome few other *Laminæ*, which lie neareſt to this, they want no more than the thickneſs of what is above them, and do every where, as well where they proceed tranſverſly, as where they are ſtreight keep a ſociable courſe, but in all the other Plates they come more ſhort of the length of the Bone, and run off from them, which cloſe up or make the extremity of it, only by ſome Corrugations and Apophyſes, which form the ſmall Cavities they come to meet, and to be united in ſome certain places. The Strings of the firſt internal Plate in thoſe Bones, which have a large Cavity, do plainly firſt divert from the ſide, or reſt of the Plates into the interſtice; after theſe the Strings of the next *Lamina*, and thus they run off one after another till we come to the extremity, where thoſe of ſome few of the external Plates, which remain running tranſverſly without any irregularities, or *Plicæ*, and being contiguous, as on the ſides, make a thinner, but compact part, which covers and ſhuts up the ends of the Bones. And as the bony ſubſtance of which the *Cancelli*, and the ſmall Cavities are formed, is a continuation of the Strings from all ſides of the Bones in thoſe, which have the large Cavities; ſo from the firſt appearance of theſe *Cancelli,* or the firſt formation of the ſmall Caverns, where there is nothing of that reticular texture, as the Strings of every *Lamina* ſtrike off to make them, the ſide or Wall of the Bone grows gradually thinner towards the extremity, ſo that by that time we come to the end of it, we have not above a fifth, or ſixth part, and it may be leſs, remaining to make the thickneſs of that part. Thus in the *Os femoris* of a Humane Skeleton I have obſerved the thickneſs of the ſide before any of the Strings ran off from it to be ~~five~~ four times more, than that of the Head. So that if we ſuppoſe the ſide to conſiſt of five and thirty Plates, then has the Head but ſeven which lie contiguous to one another, and incloſe the Cavity.

Perhaps it may not be ſo eaſily underſtood how the Strings of the exterior Plates are continued at the ends of the articulated Bones, which are covered with a cartilaginous ſubſtance ſuppoſed to be diſtinct from the Bone, but the parts, of which theſe Cartilages conſiſt, are the ſame as thoſe, which make the Strings in the more ſolid part, diſpoſed in the ſame order, ſo that the Series of the Particles of ſo many Strings, as anſwer to the thickneſs of the Cartilage, run through it, and would be continued in the Nature of a ſolid bony String, but that the liquor, which is continually ſupplyed to the Joynts, will not ſuffer the Particles to be ſo intimately united, as to render that ſubſtance of that part equally hard.

The Bones in their firm, and ſolid part, and where the ſmall Cavities are diſtinct conſiſt of ſeveral *Laminæ*, or thin Plates lying one within, or under another. So that there is this ſubordination, in the Conſtituent parts of a Bone, a proportionate quantity of Earth, and Salt duly mixt, produce the Particles; the Particles regularly diſpoſed, and united at their extremities in every Series form the Strings; the Strings laid in a convenient Order, and Number, and ſo united form the Plates; and theſe Plates make up the Bone. I ſay the Bones in their ſolid part, and where the ſmall Cavities are diſtinct are formed thus of Plates, becauſe where any part of their Structure is like Network, or *Cancelli*, which are to be found in many of the Bones of a Human Skeleton, and more than in other Animals, the Strings are not ſo ordered, and united as to make any Plates, but run into ſeveral *Faſciculi* of thoſe ſmaller Strings. Now ſince the Strings of which theſe *Laminæ* conſiſt are, as I have already ſhewn, after the perfection of the Bone ſo continued from one ſide to the other as to have no diſtinct extremities, every one of theſe Plates excepting thoſe, which have their Strings at any end running into *Faſciculi*, could they be divided entire, would be like a Tube imperforated at both ends. Yet I did in two Oxes Bones, which were freſh, meet with a ſmall *Lamell*, which lay next to the *Perioſteum*, that fell much ſhort of the length of the Bone, and did not lie round the Cavity ſo as to be Tubular, but I lookt upon it to be extraordinary, and not agreeable to the common method of Nature.

There is ſome difference in the manner, wherein the *Lamells* in ſeveral Bones are diſpoſed; where there is a large Cavity they are on every ſide contiguous, and cloſely united, and the ſmall Caverns,and *Cancelli*,which are at the extremities, are produced from Plates, and Strings propagated from the ſides: But in the Bones, which have not any great Cavity, but are altogether ſpongious within, many of the internal *Laminæ* are placed at ſome diſtance from one another in all their length, excepting in thoſe ſeveral places, where the flexure of their Strings this way, or that, and their Apophyſes bring them to meet, and being thus modified all along juſt as they are at the extremities only of the Bones, which have a large Cavity, they produce in the whole internal part the ſame ſort of ſmall bony Cells. And becauſe many of the Plates within ſtand thus diſtant from one another, they fill up the whole ſpace within the Wall or ſolid part, with ſuch a cavernous ſubſtance, and therefore the ſides in theſe Bones are thinner, and the Plates which are contiguous, and are their ſolid part, are fewer than in thoſe, which obtain a large Cavity.

On the inſide of the *Os Humeri* of a Humane Skeleton, I have ſometime found the firſt Plate, from one end of the Cavity to the other, puft up in ſeveral places, ſo as to form conſpicuous Cavities under it, but round every one of thoſe Cavities it was depreſt, and remained united to the next *Lamina*, and where it was thus elevated, I took notice of a great many Pores, by which I do ſuppoſe the Medullary Oil did paſs out of the large Cavity into thoſe, which were under this Plate, and were ſome of thoſe tranſverſe Pores, by which the Marrow is conveyed in order to diffuſe itſelf between the *Laminæ*, and which I ſhall preſently give an account of.

Of theſe Plates I have in one Bone with a Microſcope numbered ſixteen together, and by computing the number of thoſe, which I could not ſo well diſtinguiſh, by the thickneſs of them, which were diſcernible, I reckoned them all to be three or four and thirty. In another Oxe's Bone I counted one and forty together, which I could plainly diſcover, the reſt I could not ſo well, becauſe they did not lie ſo ſtreight, and regular on that ſide next the Cavity, as that I could be certain as to their number, but yet I diſcerned they were diſtinct Plates, and I numbred them ſo well as I could, which were by that account fourteen, ſo that they were in all five and fifty.

That the Bones do thus conſiſt of ſeveral thin Plates lying one over another we have preſumptive evidence from their exfoliation, and conſidering how much the Horns of Beaſts participate of the Nature of Bones, and how many of them may be actually divided into ſeveral thinner *Lamells*, this may induce us to think that the Bones are in the ſame manner made up of *Laminæ.* But we have further evidence of it, as they may be diſtinguiſhed with a Microſcope, and not only ſo, but I have actually ſeparated them in ſeveral Bones, particularly I have taken ſome of the thin, and fine *Laminæ* off from a piece of a human Skull, and in one Bone I had, I could divide the whole Wall from the Cavity to the external ſuperficies into Plates, though ſome of them I muſt confeſs were thicker than others; but when I viewed any of the Plates with a Glaſs, and numbered ſixteen, or more together, whilſt they were yet united I could not diſcern any ſuch difference in their craſſitude, ſo that I am confident, that thoſe, which I found upon ſeparating of them to be thicker than others, and which I could not divide into ſuch thin and curious Plates, as I did ſome, did conſiſt of thinner, and finer *Laminæ*.

The manner how the Bones conſiſt of ſeveral Plates included one within the other, and how the ſmall Caverns, and Latice-Work are produced, I have endeavoured to expreſs in the firſt Figure, Tab. I. where *a, a, a.* are the Plates in the ſides of a Bone, which muſt be ſuppoſed to be contiguous, although I have made them diſtant to repreſent them diſtinct, the four exterior of which are parallel and contiguous at the extremities *b, b.* as well as in the ſides *a, a, a. c, c.* is the Latice-Work produced from the Strings propagated from the Plates *d, d, d, d. e, e.* are the Caverns formed of the Plates *f, f, f, f, f, f.* which run off from the ſide ſucceſſively, where the craſſitude of the ſolid part appears gradually diminiſhed, *G.* is the large Cavity, and *h, h.* the paſſage of the Medullary Vein, and Artery.

In the Bones through, and between the Plates are formed Pores beſides thoſe, which are made for the paſſage of the Blood-Veſſels, which are of two ſorts, ſome penetrate the *Laminæ*, and are tranſverſe looking from the Cavity to the external ſuperficies of the Bone. The ſecond ſort are formed between the Plates, which are longitudinal, and ſtreight, tending from one end of the Bone towards the other, and obſerving the courſe of the bony Strings. And that I may not be thought to pretend to the diſcovery of what no other mens Eyes can diſcern, becauſe they are generally very difficult to be obſerved, unleſs it be the tranſverſe Pores in the internal *Lamell*, I have the pieces of two Bones, which I have brought along with me, in one of which, the tranſverſe, in the other the longitudinal Pores are very viſible with the help of an ordinary magnifying Glaſs.

The firſt kind of paſſages are formed not only in the firſt internal *Lamina*, but in every one, even to that which includes all the reſt, and I have not only ſeen them ſometimes in thoſe parts of a Plate, which in the Cavity have been naturally puſt up, and raiſed from the ſide of the Bone, and in the next *Lamell* to that, but I had the ſatisfaction in that Bone, which I reſolved into Plates, to obſerve ſome of them in all the Plates. Though ſo far as I have obſerved the nearer they are to the

Cavity the greater is the number of theſe Pores, which in the firſt internal Plate are very numerous. Now this difference in the number of the tranſverſe Pores, beſides what I gather from what I have obſerved, we may ſuppoſe for theſe two Reaſons, firſt becauſe the quantity of Marrow, which is to paſs through them is leſs, and leſs, as it approaches nearer to the outſide of the Bone; for the Marrow being ſupplyed from the Cavity, every Plate tranſmits ſo much as is neceſſary for its own uſe, and all the Plates, that lie above it, ſo that every one as it approaches nearer to the ſuperficies, having a Plate leſs than another to tranſmit the Medullary Oil to, there is occaſion for a ſmaller number of theſe Pores in one than in another. Secondly, becauſe it was neceſſary the Bone ſhould be very ſolid towards the ſuperficies, where it is expoſed to external injuries. About theſe paſſages I was particularly ſtrict in my enquiry, whether they were not formed for Blood-Veſſels tending either to, or from the Marrow, and although ſome of the Medullary Veins have Pores by which they penetrate into the ſubſtance of the Bone, yet I made my ſelf certain that theſe Pores for the generality of them, which I examined, had no Veſſels, which paſſed into them. Theſe tranſverſe Pores do not obſerve any ſuch order as to lie directly one under another to form one continued paſſage from the Cavity to the external Plate. This could not be, but Nature muſt either have been fruſtrated of her end in making them, or injurious to the ſolidity of the part. If they had been continued through the whole thickneſs of a Bone, and limited to their preſent number, without the other Pores which are formed between the Plates, it had been but a ſmall part of the ſubſtance of a Bone, that could ever have been touched, and had the benefit of that oily matter, which they ſerve for the diſpenſation of. If they had been ſo thick, and numerous, as that all the ſubſtance of a Bone could have been oiled by the inſinuating Marrow without the longitudinal Pores, this had been as injurious another way, and ſuch a poroſity would have deſtroyed that ſolidity, and firmitude, that were neceſſary in theſe parts, which are the Timber-Work, and Supporters of all the reſt. For the tranſverſe Pores, which interrupt the continuity of the Strings, that conſtitute the Plates, would have detracted much more from the ſtrength, and rigidity of the Bones, then thoſe, which are formed in the length of the Strings, and between the *Laminæ*, which is eaſily demonſtrable. But by the contrivance, which appears, Nature attains one end in ſuch a method as does not diſappoint her of another, but both makes her Bone firm, and in the diſpenſation of the Marrow is juſt, and kind to the whole ſubſtance of it.

As the tranſverſe Pores are differently placed in the ſeveral Plates ſo as not to receive the Medullary Oil immediately one from another, ſo thoſe in the ſame *Lamell* are diſpoſed with a ſeeming irregularity, and ſcattered, not being digeſted into ſuch an order as to form Circles, or exact ſeries of Pores round it, which thing is yet regular, and reaſonable, and without doubt is done *ex propoſito,* that the Plates might not be weaker, and more apt to be broken in one place, than in another. For although they had not exceeded their preſent number, yet ſuppoſing they had been ſet in ſeveral ſeries round a Plate ſo as to delineate Circles about it, this would have made it more infirm and apt to be broken in thoſe than in other places, or than now it is in any part.

Beſides theſe there are longitudinal Pores formed between the Plates, which in the ſides of the Bone have a tendency from one end towards the other, and where the Strings alter their courſe, and are tranſverſe to the Cavity that is at the extremities, they ſtill run along between the Plates, and change their Poſition, as the Strings do. Theſe are not very commonly to be obſerved, nor without

out a ſtrict inquiry, and good Glaſſes, unleſs t be now and then in ſome particular Bones. There are none in which they are oftner capable of being obſerved than in the Ribs. Though I have in the firmeſt part of a *Scapula*, where the Plates were immediately united plainly diſcerned them, and even ſeen the Marrow, which had inſinuated itſelf into them, ſticking to their ſides in the ſhape of an Oil. I have likewiſe had the ſatisfaction to obſerve them in a human Bone, and that between eleven, or twelve ſeveral Plates. By theſe it is that the Medullary Oil diffuſes it ſelf, and is immediately beneficial to the Plates; the tranſverſe Pores are ſubordinate to theſe, and rather deſigned for the paſſage of the Marrow into them, than for the immediate communication of it to the ſubſtance of the Bone. The manner therefore, in which the Medullary Oil inſinuates itſelf through a Bone, and is diſpenſed to all the parts of it, is this; it firſt paſſes being liquid, as it all is whilſt the Animal is alive, out of the Cavity through the tranſverſe Pores of the firſt internal *Lamina*, and not having Pores of the ſame kind directly ſubjacent in the next Plate to tranſmit it towards the outſide of the Bone, it flows into the longitudinal Pores formed between theſe two, the firſt, and ſecond Plates, and being carryed along in them till it finds ſome tranſverſe Pores in the ſecond Plate, it paſſes through theſe, which when it has done it is again obliged to alter its courſe to run into, and flow along in the ſtreight Pores between the ſecond, and third *Laminæ*, thus it paſſes through and between the Plates ſucceſſively, till it has made its way through the ſolid part to the external Plate. Thus the Medullary Oil is diſpenſed in all the Bones to thoſe Plates, which are contiguous, and have no intermediate Cavities to entertain any Medullary Glands of their own, but where any part of the Plates ſtand at ſome diſtance, being only united by intervals as their Corrugations bring them to meet in ſome certain places, there we have the ſmall Caverns, which are capable of containing ſome Medullary Glands, ſo that here the Plates have more immediately, and without the former method of conveyance the benefit of the Marrow.

Of the Superficies of the Bones, their Paſſages formed for the Medullary Veſſels, and their Cavities.

NOW I have conſidered the Conſtituent parts of a Bone, I proceed to examin it entire, and to take notice of the ſtructure, which ariſes from the compoſition of its parts, and the order, in which Nature has diſpoſed the Plates, and the firſt thing, which falls under our obſervation is the ſuperficies, which in all the Bones excepting only at the ends of thoſe, which are articulated, where it was neceſſary that they ſhould be ſmoother to make them more fit to be moved, and managed by the Muſcles, is remarkably unequal (though more in ſome than in others) from Cavities, whereof ſome are ſuperficial, others are paſſages, which penetrate farther into their ſubſtance, the moſt conſpicuous of which are thoſe, through which the Blood-Veſſels of the Marrow, and the Arteries, which are deſigned for the nouriſhment of the Bones, do enter.

The ſuperficial Cavities, which ſome may think to be accidental, are not the careleſs ſtrokes, but the deſign of Nature, and are hoſe inequalities, which I have already in ſpeaking of the *Perioſteum* obſerved to be a contrivance to inlarge the ſuperficies of the Bones, and to ſtrengthen the adheſion of that Membrane to them. They are of two ſorts, ſome are long, and theſe we may call *Sulci* or Furrows, others are more contracted in their length and of a different Figure, which may be diſtinguiſhed from the former by the name of ſuperficial Pits or depreſſions.

Of the *Sulci* ſome are larger and broader, ſome longer, and ſome more ſuperficial than others. But they all generally agree in this, that they obſerve the poſition of the Particles, and the courſe of the Strings in the Plate, in which they are formed, ſo as to run directly the ſame way as they lie, though in the *Os Hyoides* I obſerved ſome few of them to be different, ſome were of the figure of an S, and others were plainly Oblique to the courſe of the Strings.

Of the ſuperficial Pits ſome are broader, and larger, others, and much the greateſt number of them, are ſmaller. Many of theſe laſt are round, thoſe which are larger are irregular in their Figure, and ſeem to be a ſort of *confluentes*, or ſeveral of the little Pits run one into another. I have in ſome of theſe larger depreſſions obſerved others that were ſmall, that there were Pits within a Pit. I have though rarely ſeen of theſe ſuperficial

Cavities running a little way under the Plate, in which they were formed, into which the *Perioſteum* by a Protuberance anſwering to it, did inſinuate itſelf.

Theſe inequalities of the *Sulci*,and ſuperficial depreſſions do not obſerve the ſame proportion in their number in all the Bones, ſome have more Furrows, ſome more Pits than others. The *Os Humeri*, and the *Tibiæ*, and eſpecially the Thigh Bone have a great number of the Furrows, ſome of which are deep and conſiderably long, three inches and more. Beſides theſe they have the ſuperficial depreſſions, and that ſome of them in the very Furrows themſelves, which are large. The *Ulna*, and *Radius* have Furrows too as well as Pits, though the firſt has the greateſt number of them. The *Fibula* has conſiderable Furrows in ſome places, though it has not ſo many to ſhew us, but abounds chiefly with the other ſuperficial Cavities. Some of them are likewiſe to be obſerved in the Bones of the *Metacarpus*, and *Metatarſus*. Thus they have appeared in thoſe Bones,where I did induſtriouſly obſerve them, but I ſee little reaſon why they ſhould be conſtantly alike in all Skeletons, ſo that it is probable Nature does here change her hand in ſome Subjects, and form more ſuperficial depreſſions, or more Furrows in the ſame Bones of ſeveral individuals. In ſhort many of the Bones have ſome of both ſorts, and all have the ſuperficial depreſſions. But in the upper part of the *Os Frontis*, and in the Bones of the *Sinciput* at thoſe Angles, which meet in the Coronal Suture, and all along on both ſides the *Sutura Sagittalis* I have obſerved in ſeveral human Skulls, not ſo much this contrivance of ſuperficial Cavities for inlarging their ſuperficies, and ſtrengthning the adheſion of the *Perioſteum*, as numerous Pores penetrating into the ſubſtance of thoſe Bones, particularly in one of the Skeletons in the Repoſitory they are very numerous, exactly repreſenting the tranſverſe Pores of the internal *Lamina* in the large Cavities of the great Bones of the joynts, and in one Skull I found many of them planted more backward down the middle of the *Os Occipitis*. The ſame I have met withal in the *Os Frontis* of an Ape, and in a Tyger where I ſuppoſe the ~~Tendons~~ Fibres of the Temporal Muſcles reached to the Sagittal *Sature*, I found them only in the Bone of the Forehead; and I obſerved the like in the *Oſſa Sincipitis* of one Rhinoceros, on both ſides of the Sagittal Suture. The reaſon of which difference to me ſeems to be this, becauſe where theſe Pores are to be obſerved in the Bones of the *Sinciput* there are the Tendons of no Muſcles inſerted, ſo that there was no reaſon to contrive for ſo firm an adheſion of the *Pericranium* to theſe parts, and indeed not much more in the *Os Frontis*, for though there are Muſcles, which have their Origination from it, yet they are no more than the *Muſculi Frontales*, which only Corrugate the Forehead, and help to raiſe the upper Eye-lids, when we would open them very wide, and ſo have no great ſtreſs, or weight depending upon them when they act. Since therefore there was no great occaſion for theſe ſuperficial Cavities, Nature in thoſe parts of the Bones I now mention'd has formed Pores to another end, and may here be thought to be upon a deſign for the preſervation of our Health, and the greater ſecurity of our Lives. As it was requiſite that the upper Region of our Bodies, where the Soul, that actuates, the Sun, that irradiates the leſſer World, is ſeated, ſhould be clear, free from Clouds, and Vapours, ſo theſe Pores ſeem to be formed as one way to expel, and ſcatter thoſe moiſt, and miſty Particles, which may be apt to eclipſe, or weaken the influences of that Principle, which animates us. I do therefore conceive that they are *Perſpiracula* by which the offenſive Vapours, which ariſe, and gather within the *Cranium* do perſpire. And it may ſeem more probable if we conſider how Sweats do eaſily, and frequently ariſe in the Forehead, even when they are not diſcernible in other parts,to account for which we may reaſonably ſuppoſe that there is ſome other way of evacuation beſides what is made from the Maſs of Blood by the Cutaneous Glands, which are to be found in any part of the Skin as well as there. I know the practice both of antient and modern Phyſicians have in taking off the Hair, and the application of Plaiſters as well for clearing, as ſtrengthning of the Brain, directed to have them done upon the crown of the Head, not that they did as I can find ever take notice of theſe Pores, though Anatomiſts do ſuggeſt that the ſubſtance of the Bones of the *Syncipur* are therefore thinner, and more rare than that of the other Bones, that there may be a more free, and eaſie exhalation of Vapours, which implies a ſuppoſition that there are ſuch Pores. I muſt confeſs I have not met with them in all the Skulls, that I have examined, and perhaps the difference may make ſome variation in the ſtate of the Brain, the want of them may be the occaſion of a natural dulneſs, and cloudineſs, it may render us obnoxious to a frequent Head-ach not only upon the accident of a Cold, or any other evident occaſion, but even where the Craſis of the Blood is good, and no accountable cauſe has fallen under our Obſervation.

Whilſt I ſuppoſe ſome of the ſerous Particles, which are evaporated in theſe parts, to come from the Brain immediately, or without the mediation of the Blood-Veſſels conveying them to the Cutaneous Glands, ſome will be apt to think I ſpeak as if I had never heard of thoſe Glands, and did not underſtand the manner, in which the *Serum* is commonly excerned when we Sweat. But that there are ſubtile Vapours continually ariſing within the *Cranium* I think cannot be denyed, and that they are ſucceſſively excluded as they ariſe is as certain, whether they paſs through the Skin by the Cutaneous Glands, or ſome diſtinct Pores is not material, but the queſtion is whether the Cavity of the *Cranium* be freed from them *mediante ſanguine*, as they are reſorbed by the Blood-Veſſels, and carried in the Maſs of Blood to the Cutaneous Glands, or whether there be not a more immediate way by Pores and Interſtices in the parts guiding, and carrying them, though perhaps meandrically to the external part of the Head. This I am ſure we all ſeem to grant, that there are ſuch immediate paſſages, by which not only the tenuious Vapours, but more groſs, and morbifick Particles may be evacuated out of the Cavity of the Skull, when we preſcribe Iſſues in the Neck, and upon the crown of the Head in any Cephalick Diſtempers: for if they were not conveyed ſome other way than by their return into the Maſs of Blood, and their Circulation through the *Sanguiferous* Veſſels to theſe artificial *Emunctories*, I do not apprehend why an Iſſue in the Heel, or any other part ſhould not be as proper and beneficial in thoſe caſes, as in that part, where we ſo preciſely order them. Some that perhaps would allow ſuch a Perſpiration as I ſpeak of, if the including parts were only membranous, will object the thickneſs, and ſolidity of the Bones, through which theſe Vapours muſt paſs, but if they do conſider thoſe two ſorts of Pores formed in the moſt ſolid part of a Bone, which I have before given an account of, they may be ſatisfied that even theſe ſolid parts are permeable to a thin, and tenuious matter.

Beſides their ſuperficial Cavities the Bones have all of them deeper impreſſions, *Foramina*, which not only renders their ſuperficies unequal, but penetrate far into their ſubſtance, where the moſt remarkable, and they that deſerve or admit of our particular notice, are thoſe by which the Blood-Veſſels paſs through the ſide of the Bone to the Medulla. The *Foramina*, by which the nutritious Arteries enter the ſubſtance of the Bones, are in ſome places very viſible, but not ſo conſpicuous as the other, nor ſo conſtantly agreeable in all things that they can well be particularly deſcribed, in general many of them are at one end of the Bone, and the contrary to that where the Veins paſs out, and there are ſome planted in the intermediate parts between the two extremities, which are but ſmall. The paſſages of the Veins excepting them, which accompany the Medullary Arteries, are very numerous and minute, but there is nothing particular in them to be obſerved excepting their number.

As for the paſſages of the Medullary Arteries, and the Veins, which accompany them as they are but few ſo they are conſiderable. This is to be remarked that they do not penetrate the ſide of the Bones, eſpecially thoſe, which are articulated directly into their Cavities, but with an obliquity like the paſſage out of the Ureters running for ſome way between the Coats of the Bladder, before it opens into the Cavity, ſo that I have found this paſſage ſometime to be an Inch, and half, when the thickneſs of the Bone was little more than the eighth part of an Inch. In this manner they are generally formed in Beaſts, and Fowls, as well as Men. But more obliquely in Men, and ſome ſort of Beaſts, than in others. In two Rhinoceroſes ſome paſt almoſt directly through, and none of them ſo obliquely as in Men, and ſome other Creatures: the reaſon of which ſeems to be becauſe the Bones of the joynts in them are very ſhort; ſo that the ſame obliquity of the paſſages, which ſeems to be for this cauſe, that they may not detract too much from the ſtrength of the Bone in that part, was not ſo neceſſary here. There is no Membrane inveſts the ſides of theſe paſſages, neither is the *Perioſteum* on the outſide, nor the Membrane of the Marrow within ſo kind as to communicate any part as a covering to them. They are moſt obſervable in the Bones of the Joynts, the *Ileum*, *Clavicles*, and the lower Jaw. The *Os Humeri*, and *Os Femoris* have ſometimes two or three, the *Radius* and *Vlna*, the *Focile Majus*, and *Minus*, the Bones of the *Metarcarp*, and *Metatarſe*, the *Oſſa Seſamoidea*, and almoſt all the Bones of the Fingers and Toes have commonly one, the *Ileum* has three, two on the inſide, and one external. But I muſt confeſs I have obſerved that Nature ſo little confines herſelf either as to their number, or the particular place in the Bone where ſhe forms theſe *Foramina*, that I can hardly ſay I have found them all alike in theſe reſpects in any two Skeletons, that I have made the ſubjects of my enquiry. In their tendency theſe paſſages are more conſtant, and I have found that the Skeletons both of Men and Beaſts do generally agree, ſo that where a paſſage runs upwards, or downwards the ſame

Foramen, or that, which anſwers to it, does in the ſame Bones of all ſuch Skeletons commonly tend the ſame way, eſpecially in the lower Jaw, the Clavicles, the Ribs, and the large Bones of the Joynts. In the *Os Humeri*, the *Tibia*, and *Fibula* they run downwards, in the *Os Femoris*, the *Radius*, and *Vlna*, they paſs upwards, ſo that we may obſerve that in thoſe Bones, which anſwer to one another in the upper, and lower Joynts, they have a contrary tendency, which there ſeems to be ſome reaſon for, becauſe it is generally ſo, though it ſeems difficult to give one, that may be ſatiſfactory: that, which I have been thinking of, is the difference there often is in the poſition of theſe ſeveral parts with reſpect to the Trunk of the Body, and the *Aorta*, the poſture of the Cubit is frequently tranſverſe to them, and the Thigh-Bones when we ſit lie at Angles with the *Spine*, and the great Artery, ſo that the reflection of the Medullary Arteries is better admitted here than in the Shoulder, which is more parallel, or in the Bones of the Leg, whoſe poſition is direct to the *Aorta*, where their courſe muſt have been perfectly contrary to it, though it muſt be confeſt that the Cubit, and the Thigh-Bones are frequently poſited in the ſame manner with reſpect to the Trunk of the great Artery. But I ſhall ſhorten my account of theſe obſervations, which it is hardly worth our time to inſiſt upon. In the Lion, the Goat, the Antilope, the Rhinoceros, and the Bones of all other Beaſts that I have examined, they ordinarily obſerve the ſame tendency as in Men, though in the Bone of the right Thigh, and the *Fibula* of one Rhinoceros they did differ, but in another they did exactly agree with what I had commonly obſerved in humane Skeletons. In the Oſtridge, and generally in all Fowls theſe paſſages in all the large Bones of the Joynts tend downwards.

From the ſuperficies of the Bones by the guidance of theſe paſſages we come next into their Cavities, (for the *Laminæ*, which make the ſide or wall of the Bone, I have already given an account of) and we will firſt take a view of their internal or concave ſuperficies, where the Cavity is large, and the internal *Lamina* lies fair to be ſeen. Here we have no ſtreight Furrows, nor ſuperficial depreſſions, as there are on the outſide, and that becauſe there was not the ſame, nor any reaſon to exact them, though on the inſide of the *Cranium*, (which yet ſpeaking ſtrictly is not the internal part, which indeed is between the Tables) there are Furrows, but they are accidental, formed by the turgeſcence, and preſſure of the Blood-Veſſels, which therefore are not ſtreight, and parallel like thoſe on the outſide of the Bones, but repreſent the branches of thoſe Veſſels, that made the impreſſions. I have likewiſe, though rarely, obſerved the like on the inſide of the large Bones of the Joynts.

The Cavities are not all alike, but variouſly formed, obtaining a difference both in their figure, and capacity, beſides what the particular figure, and magnitude of the Bones, in which they are formed, do oblige them to: they are of two ſorts, the one are large, and they are ſingle in every Bone, where ſuch a Cavity is formed, the other are little bony Cells, which are numerous, and make the ſpongious part.

The Bones, which have the large Cavities, are the *Os Humeri*, and *Femoris*, the *Ulna*, *Radius*, *Tibia*, and *Fibula*, the Bones of the *Metacarpus*, *Metatarſus*, of the Fingers, and Toes, and thoſe of the *Os Hyoides*. To which we may add the lower Jaw, though the Cavity compared with the magnitude of the Bone hardly deſerves to be ſtiled large, neither does it ſerve to entertain a Medulla, but only the Nerve and the Blood-Veſſels. And the Bones of an Oxe's heart I have obſerved to have very large Cavities, that is in proportion to their bigneſs, and when I aſcribe large Cavities to any ſmall Bones, as ſome of the Fingers and Toes, it is to be ſo underſtood; for there are ſome of thoſe, which I reckon amongſt the ſmall Cavities in ſome large Bones, will be found to be more capacious than thoſe, which I ſtile large in theſe.

In the *Os Humeri*, the Thigh-Bone, the *Tibia*, and *Fibula*, ſo in thoſe of the *Metacarpus*, and *Metatarſus*, the large Cavity after it approaches towards their extremities often begins to be divided by bony partitions, and to be occupyed by ſome of the bony Strings, ſhooting from the Plates in the ſides of the Bones in *Faſciculi*, and forming larger Strings, which do not produce any incloſed Caverns, but the partitions are open, ſo that they cannot be called diſtinct Cavities, therefore I make all that part ſo far as they appear, to be a part of the large Cavity. The *Faſciculi* proceeding from one ſide till they meet with others, which are propagated from the oppoſite ſide, are united ſo as to be ſo many continued Strings as I have already ſhewn, and ſhooting forth laterally as they proceed, by a ſort of Apophyſes they are joyned to thoſe *Faſciculi*, which are parallel, and do in the ſame manner ſhoot out on their ſides to meet them, from whence ariſes a texture, which repreſents a ſort of *Cancelli* or Lattices. Where theſe *Cancelli* begin firſt to be formed the *Faſciculi* are very ſmall, and fine, when they approach near to the ſmall Cavities they grow larger. Here we may obſerve with what caution Nature proceeds in detracting any thing from the ſide, and ſolid part of the Bone, for the danger of a Fracture in theſe Bones being leſs as the violence is offered nearer to the extremity, and ſo ſome parts of the *Laminæ* accordingly can better be ſpared from the ſides, therefore they are gradually diverted from it, we have not a whole Plate run off together at firſt, but only ſome minute *Faſciculi*, afterwards larger and larger as they can be ſpared, till at laſt they are ſo large as to meet, and be contiguous, and ſo are continued in the form of an entire Plate. The Interſtices between the *Faſciculi* are many of them of a quadrangular figure, though there are abundance of them, which have divers other figures.

Amongſt theſe *Cancelli* are ſometimes broad Plates, which are produced from the ſame Strings as that texture is formed of, when ſeveral of them run together in that order, in which they lay before they ran off from the ſide of the Bone. Theſe Plates are ſometimes to be obſerved in the very middle of theſe *Cancelli* at ſome diſtance from the ſide of the Bone, ſometimes they are contiguous to it, where they recede from the Wall of the Bone in their proper form, and afterwards are divided into ſuch *Faſciculi* of the Strings, as that texture is made of. Sometimes after the large Cavity comes to be thus divided, and occupyed by the bony partitions of theſe Latices, it opens again into a large Cavity, which is free from any ſuch kind of texture, only there is ſomething of it round about on the ſides, and at the end of it the Strings run into this form again, but there is not much of this Lattice-Work before the Cavernous part, or ſmall diſtinct Cavities begin to be formed. But commonly when the large Cavities come once to have the *Faſciculi* divert into them, and to be divided by them into little Interſtices, this Lattice-Work is continued to the leſſer Cavities, and when it approaches near to them the *Faſciculi* grow gradually broader, and broader, till they all meet in ſuch a manner as to run together in the form of irregular Plates, and when they are thus met, and united they begin to make the little diſtinct Cavities, which firſt appear next the ſides of the Bone with ſome of the *Cancelli* ſtill continuing in the middle. In the *Tibia* of a Horſe I have obſerved this texture as fine, and curious, as in any Bones that I have examined, and I do not queſtion but there is much of the ſame texture in Camels, and other Beaſts that are deſigned for burden, and where the reaſon, that required ſome particular care, and contrivance to make them ſtrong, did make it neceſſary to be cautious, and ſparing in detracting from the ſolid part, and dividing that ſtrength, which was united in the ſides before. In Cows there is little of this Lattice-Work, and that very coarſe. In the Bones of thoſe Fowles, which I have examined, which have been of ſeveral ſorts, I find nothing comparable to this texture: in thoſe of the Joynts, which are large, and where it might be expected; there are indeed ſome large bony Strings, or *Faſciculi* of the ſmall ones running out from the ſides into the Cavity, but they are commonly diſtinct, and ſingle, paſſing from one ſide to the other ſometimes obliquely, ſometimes directly tranſverſe, that they appear like little bony beams lying acroſs, though ſometimes ſome few of them run into the form of a Lattice. And without doubt theſe *Trabes* in Fowles anſwer to the Lattice-Work in ſome other Animals, and the uſe and deſign of both is the ſame, which I proceed to ſay ſomething of.

The deſign therefore of theſe *Cancelli* is in the upper part of the Bone to ſuſtain that part of the Marrow, which fills the large Cavity, which in thoſe Bones, that are large, has a conſiderable bulk, but is ſuſpended partly by the ramifications of the Blood-Veſſels, and their continuation from the larger Maſs of Marrow into that which is lodged in the *Cancelli*, ſo running over, and winding about the *Faſciculi*; partly by the Membrane of the Medulla, which is one continued Membrane through all the large Cavity, the Lattice-Work, and the ſmall bony Caverns; ſo that though the Marrow in ſuch a quantity is ponderous, though the Medullary Bags, and Glands are tender, and as well as the Blood-Veſſels eaſily compreſt; yet by this Providence the Superior part having a dependence upon the Strings in the *Cancelli*, cannot make a preſſure upon that part, which lies under it, ſo as to injure it. And therefore in the Bones of an Ox, where there has not been this contrivance, or but little of this texture, I have obſerved another thing almoſt equivalent to it, that is a jetting out of ſome Plates like ledges or ſhelves lying tranſverſe, for the Marrow to reſt upon in ſeveral places, ſometimes in the middle, but moſtly towards the extremities, where this Lattice-Work ſhould be planted. At the lower end of the Cavity this texture is no leſs ſerviceable, where it bears off the preſſure of the ſuperior, and incumbent part of the Marrow from that, which is lodged in its Interſtices, and preſerves it inviolated.

Before I proceed to give an account of the leſſer Cavities. I ſhall inquire into the reaſons why the Bones of the Joynts (excepting thoſe of the Wriſt,the *Tarſus*,the *Oſſa Seſamoidea*, and the *Scapulæ*) and one or two more have a large

Cavity, and they ſeem to be two. Firſt the largeneſs of the Cavities was a conſequence from what was neceſſary to be done in order to make the Bones firm, and ſolid. It is plain that the Bones, which are of any length, are in the greateſt danger of being either fractured by any violent blow inflicted laterally, or diſtorted by too great a preſſure made at their extremities, in thoſe parts, which are diſtant from their extremities, and therefore it was neceſſary that the ſtructure of theſe parts ſhould be ſuch as would procure them the greateſt ſolidity, and firmitude, which was not conſiſtent with thoſe diſtances of their parts, from which the ſmaller Cavities ariſe, and therefore the Plates are ſo diſpoſed there as to be contiguous, from which cloſe application of one to another in the ſides of theſe Bones there follows a large Cavity within them, which is more than equivalent to thoſe leſſer Caverns, which any other order, or diſpoſition of the *Laminæ* might produce.

Secondly, They were deſigned for ſome end, to wit, that theſe Bones might be capable of containing a greater quantity of the Medullary Oil. For being Bones, which are frequently in motion they require, and expend greater quantities of that oily matter, than any of thoſe, which are not articulated, as they employ it not only for preſerving themſelves in a due temperament, and their ſecurity againſt that dryneſs, which would render them more fragil, and does as we find by experience make them apt to crack; but likewiſe with the help, and mixture of a mucilage to lubricate their extremities, when they are moved, and to maintain them in a condition fit for their motions upon all occaſions. For this reaſon it is, that the Bones of the *Os Hyoides* have their large Cavities; becauſe they are as frequently moved as we ſpeak, or ſwallow. And how evidently does the ſame reaſon appear in the Bones of an Ox's Heart, (which, as often as I have obſerved them, have been two, and articulated) when they are continually in motion upon every Syſtole, and Diaſtole of the Heart? There are, it is true, ſome Bones of the Joynts, which have not ſuch large Cavities; as the *Scapula*, the *Rotula*, the Bones of the Wriſt, and ſome others. Now for the *Scapula*, it cannot be ſaid to be moved at the articulation; for though its ſituation is ſometimes altered by its proper Muſcles, yet at that end, which only is articulated, it has the place of a quieſcent Body, upon which the *Os Humeri* moves; ſo that unleſs the *Scapula* had a Joynt at its other extremity ſo as itſelf to move upon another Bone, there was not this reaſon for the forming of a large Cavity in it. The *Rotula* is placed in a Joynt, where there is an Oil ſupplyed from the large Cavities of three Bones, the Thigh, the *Tibia*, and *Fibula*, ſo that it cannot want a ſufficient ſupply of it. For the Bones of the Wriſt, and *Tarſus*, they lye between ſuch as have a conſiderable Cavity. Another thing, which may be objected againſt what I now offer as one reaſon of theſe Cavities, is, that neither the *Os Occipitis*, nor the Atlas, which have a ſenſible motion, have ſuch a Cavity; nor yet the Ribs, which are moved ſo much in reſpiration: For the two firſt their motion is neither ſo frequent, nor ever ſo long continued as that of the Bones of the Limbs ſometimes is, the Head being only now and then turned towards one ſide, or moved backwards or forwards, and commonly it does no more than once incline to one of theſe poſtures, and afterwards returns into its more natural ſituation, ſo that the expenſe of the Medullary Oil cannot be there ſo extraordinary. The Ribs are joyned to the Vertebres by a *Synarthroſis*, or ſuch an articulation as is deſigned for an obſcure motion. And to demonſtrate the difference in their expence of this Oil in their motions, or the alteration of their poſition, let us conſider how much the poſture of the Bones of the Joynts may be, and ſometimes is altered, and how little the Ribs in Reſpiration change their poſition. When any of the Bones from an extenſion are inflected, or from an inflection they are extended, that extremity, which is remote from its centre or the quieſcent Bone is ſenſibly moved circularly, or ſo as to deſcribe part of a Circle: now by conſidering how much of a Circle this extremity makes in the Joynts, and how little in the Ribs, we ſhall eaſily diſcover a difference in the quantity of Oil, that they expend. I ſhall inſtance only in two, to wit the *Tibia*, and the Cubit; the firſt may be, and is ſometimes ſo inflected, as to make above the fourth part of a Circle, and in ordinary inceſſion about a twelfth, the Cubit ſo as to make about a third part. Whereas the Ribs, ſo far as I can perceive, in ordinary Reſpiration are not moved above the fourth part of an Inch in that extremity, which is remote from the Vertebres. Now ſome of the Ribs without their Cartilage are twelve Inches in length, but we muſt allow for their obliquity, and we will ſuppoſe the diſtance between the two extremities of a Rib to be, what it is in ſome of them, eight Inches, the Diameter of the Circle, in which the extremity diſtant from the Vertebres moves, muſt be ſixteen Inches; now ſuppoſe the Periphery of a Circle to the Diameter to be but as three to one, (though it is ſomething more) then is the Rib in that part, which is moſt remote from its centre, moved but the 192d.

part of its Circle; how inſenſible then muſt its motion be ſuppoſed to be at its Axis, or the quieſcent Bone? Only I muſt confeſs they are more conſtantly in motion than any of the Bones of the Joynts, and therefore the Caverns in theſe Bones are many of them of a long figure, and large for the ſimple ſort, and at that end next the Vertebres they have ſometimes a conſiderable Cavity.

Beſides theſe large, and more capacious Cavities, there are leſſer Cells, and they are found in all the Bones, even thoſe, which have a large Cavity, have ſome of them at both extremities,. which where the *Laminæ* lie near to one another are ſmall, and as they approach nearer to a contiguity grow leſs, and leſs, till the Plates being plainly contiguous, and united, they diſappear. There are many of the Bones, which have no other Cavities, as the Vertebres, Clavicles, the Ribs, the *Oſſa innominata, ſeſamoidea* and ſome others.

I have obſerved three ſorts of theſe Cavities. Firſt there are ſome of them eſpecially in human Bones, which have the *Cancelli*; others are ſimple, or ſingle diſtinct Cavities, which have none of that Texture; and a third ſort likewiſe have no *Cancelli*, but are like two or three, or more of this ſecond or ſimple ſort broken into one. Theſe three ſorts are generally different in their capacities, ſuch as have the Lattice-Work being the largeſt, and the ſecond kind the ſmalleſt of the three. Neither is there a difference in their capacity between thoſe of a diverſe ſort only, but of thoſe, which are of the ſame kind, ſome are larger than others. Nor do they differ leſs as to their figure than their magnitude. The firſt, and laſt are altogether of an irregular figure. Of the ſimple ſmall Cavities ſome are exactly round, ſome oval, others a flat oval, ſome quadrangular, others eſpecially in the Ribs, and Clavicles are of a long figure, and in truth to deſcribe the variety, would be to give an account of all the figures that occur in the Mathematicks.

The ſmall Cavities have all of them Pores, or paſſages of communication, whereby the Blood-Veſſels are propagated, and the Membrane of the Marrow is continued from one to another, and by which the Medullary Oil has the liberty of flowing out of the large Cavity into the leſſer, and out of one ſmall Cavity into another. But there is a great variety in the number of the Pores belonging to every ſuch Cavity, even the ſecond or ſmalleſt ſort; in ſome there are only two, one for receiving, the other for tranſmitting, ſome of the Cavities have three or four, or more; in which there is this difference that ſome have ſeveral into one and the ſame, others have a paſſage into ſeveral, or all the ſmall Cavities, that are next to them, by ſo many ſingle Pores.

Where theſe ſmall Cavities, and the poroſity, which ariſes from them, were conſiſtent with the ſecurity of the Bones, that is, where there was no neceſſity to contrive in their ſtructure that order, which would give the greateſt ſtrength and ſolidity, they were capable of, either becauſe they have not ſo great a ſtreſs put upon them at any time, or becauſe they are ſo thick and ſhort, that they are in no great danger of being broken, and where the quantity of Marrow, which theſe ſmall Caverns are capable of receiving, anſwers to the exigence of the part, as in thoſe Bones, which are not articulated; in all theſe Nature could without any danger or prejudice make their ſubſtance within all ſpongious, and has choſe ſo to do, ſo by lodging the Marrow in the ſmall Cavities formed between the Plates, does intermix with all that part of the ſubſtance of the Bones that Medullary Oil, which was neceſſary to preſerve them from growing too dry, and fragil, which was a more eaſie, and immediate way to anſwer this end, than firſt to ſeparate, and depoſite the Marrow in one large Cavity, and afterwards to ſupply it to the ſubſtance of the Bones by Pores in that manner, in which it is diſpenſed to thoſe Plates, whoſe contiguity, and union renders a Bone ſolid.

Of the BLOOD-VESSELS *of the* BONES.

I Proceed now to give an account of the Blood-Veſſels of the Bones, which are, as in other parts of the Body, of two ſorts, to wit, Arteries, which convey the Blood into them, and Veins, which ſerve in the reduction of it to the Heart, after it has paid a Tribute of ſome certain Particles to thoſe Glands, which it touches upon in its circulation. And both theſe may be ſaid to be of two ſorts, that is they are aſſigned to two ſeveral parts, ſome to the Medulla, and others to the ſubſtance of the Bones in order to their Accretion, and Nutrition.

The Medullary Blood Veſſels will fall more properly under our conſideration, when I come to treat of the Marrow, I ſhall therefore defer the particular notice of them till I come to ſpeak of that. As for the nutritious

Arteries, there are ſeveral of them belonging to a Bone, and every one of them, that I have obſerved, enters the ſubſtance of a Bone at a diſtinct *Foramen*, only I once met with two, which made their entry by the ſame paſſage. The moſt conſiderable of them enter at one end of the Bone, and the contrary to that where great numbers of the Veins have their exit, and in the large Bones of the Joynts, where they are moſt obvious to our obſervation, they plainly enter at that end, which is next the Trunk of the Body excepting in the *Scapula*; and becauſe they are Arteries, they do not alter the colour of that part of the Bone, which therefore is whiter than the other extremity, or where ever the Veins, which are red, and more numerous, do paſs out. From that end of the Bone, at which they enter, they have a tendency towards the other extremity. Some of theſe I have ſeen running amongſt the *Laminæ* in the moſt ſolid part, and where the Plates have been contiguous, and traced them a conſiderable way together, obſerving them to be ſometimes conſpicuous, and indeed large conſidering the cloſe unition of the Plates, and the ſolidity of the part, that they paſſed through, and in any part of a Bone, whilſt it is Cartilaginous, they are plainly to be obſerved, and more eaſily followed. Now though in ſome parts of the

Bones there is little, and in ſome no appearance of Blood-Veſſels, yet that they are in the whiteſt part of a Bone does evidently appear in the examination of any part of one that is yet Cartilaginous, and that they are very numerous, I have found ſome reaſon to believe from a conſiderable *Ecchymoſis* I have met with in a ſolid and perfect Bone, in that part, which ſeemed to have been naturally white, and to have given as little ſuſpicion of ſuch a thing, as any part of it.

The Nutritious Veins, if I may ſo call them, that is thoſe, which convey the Blood back from the Nutritious Arteries of a Bone are very Numerous, not throughout the whole or in every part of it, but where the Arteries terminate. For as they do not paſs through the ſame *Foramen*, ſo neither do they keep ſuch a ſociable courſe as to run one by another in the ſubſtance of a Bone, as they often do in other parts. This was neither neceſſary, nor convenient: Not neceſſary becauſe the deſign of the Veins being to carry back the Blood to the Heart, ſo long as they conveniently anſwer that end, it is ſufficient, let the courſe in which they proceed be either this way, or that. It was not convenient, for as there appears in the ſtructure of theſe parts a providence ſtudiouſly contriving what was neceſſary for their firmitude, and ordering whatever was requiſite to be done, and might be injurious to it, in ſuch a manner, as to make one conſiſtent with the other, ſo here that the paſſages, by which the Nutritious Blood-Veſſels are diſſeminated, might not be too large (which we may reaſonably ſuppoſe they would have been, if they had been ſo capacious as to give a paſſage to the Vein, and Artery together) where ever any of the Nutritious Arteries terminate, be it about the contrary extremity to that, where they enter, or in ſome intermediate part, the Veins, which ſucceed to them, inſtead of running along by the Arterial Channels, and continuing their courſe within the ſubſtance of theſe ſolid parts, paſs out immediately at their ſuperficies, and their paſſage in the ſolid part of a Bone is ſo ſhort, that vaſt numbers of them, if not all, ſeem to be at their exit out of the bony ſubſtance, ſingle Veins continuing diſtinct from the extremity of thoſe ſmall Arteries they ſerve to, that they never come to fall into any common Channel before they arrive upon the ſurface of the Bone, which I do ſuppoſe from their Number, and the minuteneſs of them.

Some Obſervations of the TEETH.

ALthough the Teeth are of the Claſſis of Bones, yet having ſome things particular, I ſhall give a diſtinct account of ſome few obſervations I have made of them, and they conſiſt of two different parts of a diverſe ſubſtance, the one is of the nature of a Stone, the other is truly bony.

The firſt may well be ſaid to be Stone, when it has the hardneſs of Stones, the ſolidity of Flints themſelves, ſo as in the ſame manner to reſiſt the impreſſions of the Saw, and has beſides ſomething of a ſhining, or gliſtering brightneſs, as the hardeſt of Stones have, though after all it muſt be confeſt that it is often eaten away, and will be diſſolved in *Aqua fortis*, which Flints will not; which, as it ſhews us how injurious ſtrong acids are to this part, may direct us to the uſe of better means for whitening the Teeth, than Spirit, or Oil of Vitriol, or any thing of that nature. This I call the *Cortex* of a Tooth, and is plainly, and eaſily to be diſtinguiſhed from the other part. The ſeveral parts or *ſtriæ* of which it conſiſts, differ in their poſition from the Strings in the bony part, not lying ſtreight in the length of the Tooth, but on the ſides oblique, near to a tranſverſe poſition in ſome Animals, and upon the upper part of the *Dentes Molares* where the bony ſtrings are tranſverſe, and at the very point, or extremity of the ſharp Teeth they are in a manner erect. The figure of theſe *ſtriæ* in the Teeth of ſome Animals is ſtreight, in ſome a little, and in others more oblique as in thoſe of Men, in which I have obſerved them to have the ſimilitude of a Bow, the convex part of whoſe Arch on the ſides lies obliquely downward, and the concave upwards, with the lower end planted, and fixt upon the ſide of the internal or bony part, which gives them a Baſis to reſt upon, ſo that when any thing preſſes upon the other extremity, they are in no danger of being protruded out of their place, having ſo firm a Foundation to ſtand upon, and being ſo diſpoſed, that all impreſſions are made not laterally, but at one end of them, and ſo as to make the greateſt advantage of their Baſis, in reſiſting that force, which might move, and diſorder them.

Conſidering the Teeth are deſigned for the breaking, and diſſolving the parts of our ſolid food, the reaſon does appear why that part, which ſtands out of the Gums, and is the immediate inſtrument of Maſtication, ſhould at leaſt be caſed with a hard and ſtony Cortex, otherwiſe they would be more eaſily injured by their action, and ſenſibly worn away. It is true ſome other Bones are rubb'd one againſt another at their articulations, where they are of a more ſoft and tender nature, without any ſenſible injury; but then there is a continual ſupply of an oily, and a mucilaginous Matter, which prevents their attrition, which neither the poſition, nor the Office of the Teeth does admit.

When a Tooth is broke, and this ſtony part is viewed with a Microſcope, it repreſents almoſt a Saw, or rather the inequalities, and notches of ſuch a Grater as is made to ſome Steel Tobacco Stoppers, excepting only the obliquity of the *ſtriæ*. So that the parts, or (which I am apt to think it conſiſts of) the *Laminæ* of it are formed with ſuch inequalities, that they are applyed, and joyned together by the way, and in the manner of a *Suture*, the Teeth, or ridges of one lying into the notches of the other.

This part does not ſeem to be allowed any ſhare of that medullary, and oily ſubſtance, which is ſupplyed to other Bones, and is not wholly wanting to that part of a Tooth, which is truly bony. For beſides that I could never diſcover any thing of a moiſt or oily nature inſinuated into it, nor obſerve any thing of an Oil to ſweat out of it, either in a Skeleton, or when it has been extracted from one living, it would be ſo far from doing any ſervice here, and preſerving the natural temperament of this part, that it would be more apt to deſtroy it, as it is, and ought to be extremely dry, and hard, and ſeems to have ſomething peculiar in its nature, and conſtitution, which preſerves it from being fragil, or friable without the aſſiſtance of any oily matter. And whether that *Mucus*, which is found ſticking upon the Teeth, is ſupplyed from within, and paſſes out of it, is to be much queſtioned, and it ſeems rather to be ſome *viſcous*, or *gummous*, and terreſtrial parts ſupplyed from the *Saliva*. And however a Tooth is thought to grow beyond its natural length, when its oppoſite is wanting, yet this is not ſo certain as not to admit a diſpute. I have obſerved that in ſome Teeth, when thoſe which ſtood againſt them have been gone, there has been no elongation. And if it were ſo that a Tooth took an occaſion to increaſe its length from the want of that, which was oppoſed to it, and of that preſſure, which it made upon it; why do not the Teeth continually protrude their lateral parts, and acquire an extraordinary thickneſs in that part of the Cortex,

tex, where there is not the preſſure,and oppoſition of another Tooth to hinder it? That therefore, which ſeems to be an elongation, may rather be thought to be the protruſion of a Tooth from an extravaſation, and the preſſure of ſome nutritious juice flowing into the Socket, as we find after a Tooth is extracted, the *ſuccus nutritius* of the Jaw is thruſt forth into the Cavity, and fills the *Alveolus* with a bony ſubſtance. Or if the Tooth does afterwards grow, and exceed its ordinary length, the addition, that is made to it, does not ſeem to be in the Cortical part. It is true,we cannot well imagine that ſo thin a ſubſtance, as hard as it is, ſhould ſerve a Man his whole life time without a reparation, ſo that we muſt ſuppoſe as ſome of the parts are worn off, they are renewed. But when the Teeth as well as other parts, have a certain and convenient magnitude preſcribed to them, and the ſolidity eſpecially of this Cortical part fixes the limits of its increaſe more firmly, and makes them more immoveable than they ſeem to be in any other part of the Body; I cannot think that the ſtony Cortex has any preternatural increaſe after the oppoſite Tooth is gone.

This ſtony Caſe or Cortex in Men, the Lion, and other Carnivorous Animals covers all that part of every Tooth, which ſtands out of the Gums, but when the Teeth come to be protected by them, it grows thinner, and quickly terminates: neither was it neceſſary that it ſhould be ſo thick, and ſtrong where it is covered ſo as not to be expoſed to that violence, and thoſe impreſſions, which the naked part ſo often meets with. In the *Dentes inciſores*, and *Canini* both of Men, and Beaſts all that part, which ſtands out of the Gums, is covered with ſuch a Cortex; but in the *Dentes Molares* there is a great difference. For in Horſes, Sheep, Goats, the Antilope, the Rhinoceros, and ſuch Beaſts as live upon Graſs, and Corn, the baſis or that extremity, which lies out of the Gums, is not covered with it, but only the ſides, and it runs to that extremity, where it ends in a ſharp edge, but ſometimes there grows over it a bony cruſt, and whereas in Men, and Carnivorous Animals there is none of this ſtony ſubſtance within the bony part, it is otherwiſe in theſe Animals, in whoſe Grinders there is the ſame ſort of ſubſtance within mixt with that part, which is bony, and that in ſeveral places, which riſes up likewiſe with an edge above the bony part, and is often continued to the extremity of the Roots: and there does evidently appear a contrivance of Providence in the formation of theſe parts in ſeveral Animals, accommodating them to the nature of the Food, which the Animal lives upon. In Men, whoſe Food is generally ſoft, and more fit to be broken into pieces by compreſſion, than to be ground, they are obtuſe. In the Lion, Tiger, Dogs, and ſuch Creatures as eat Fleſh, but are frequently entertained with no tenderer Food than Bones, though they are covered with a ſtony Cortex, they are ſharp with ſeveral points. In thoſe Beaſts, which are maintained by Graſs, Hay, and Corn, this ſtony part riſes up in ſeveral places in ridges, with a kind of edge, and does anſwer to the inequalities of a Millſtone. In Hogs, that eat Fleſh, as well as Graſs and Corn, they are covered with a ſtony Cortex, but formed in ſuch a manner as makes them of a middle nature, and fit for the maſtication of both.

Underneath the Cortex in humane Teeth, and other Carnivorous Animals, (and within the ſame ſtony ſubſtance in other Beaſts) and within the Gums is another part of the Tooth, which is truly bony. And this Bone (for ſo I may lawfully call it) conſiſts of *Laminæ* as other Bones do, which I have plainly obſerved and diſtinguiſhed in a Horſes Tooth.

From the different nature, and ſolidity of theſe two parts of the Teeth is the reaſon evident, why they are often ſo haſty in their decay, when the external or ſtony part is once broken off, that they quickly grow rotten, and hollow, when the Cortex, which is much the thinner part endures ſo many years, and is daily employed without any ſenſible detriment, and upon this account it is, that when the Gums are eaten away, ſo that ſome part of a Tooth, which is not defended with a ſtony Cortex is laid bare, it is eroded, when that part that naturally ſtands out of the Gums, and is by ſuch a ſolid ſubſtance ſecured, ſuffers no ſuch injury.

The Teeth have all of them in that part, which lies within the Gums a *Perioſteum*, but not that Membrane, which is common to the other Bones. For that, which immediately inveſts ſo much of them as is covered with a Membrane, is not a continuation of the *Perioſteum* of the Jaw-bone, but is united to, or rather propagated from that Membrane, which covers the Gums, and is common to the whole Mouth, which does not terminate with the Gums, but when it comes to their extreme edge, turns in, and is reflected between the other ſide of the Gum, and the Tooth, then it deſcends into the *Alveolus*, and adheres immediately to thoſe parts of the Teeth, which lie within. With the Membrane in ſome Teeth is communicated to their Roots, eſpecially in the upper Jaw, ſome part of the hard, and fleſhy ſubſtance of the Gums, by which the Teeth are faſtned more firmly in their Sockets. And becauſe they are parts, which ought to be firmly fixed, there is the ſame contrivance for the ſtrong adheſion of their Membrane, as in other Bones, to wit inequalities, or ſuperficial Cavities, which inlarge their ſuperficies. In Men they are often depreſſions or Pits of an irregular figure, though in ſome humane Teeth there are circular Furrows, which are conſiderably wide. In the Teeth of the Rhinoceros I likewiſe find broad and circular Furrows. In the Teeth of a Tiger theſe inequalities are alſo Furrows, which are remarkable, and numerous, but they are ſtreight, and run from one end of the Tooth towards the other.

But though the Teeth themſelves have no part of the common *Perioſteum*, yet it comes very near them, for the Sockets, in which they ſtand, have it. The *Perioſteum*, which covers the Jaw-bones running to the edges of the *Alveoli*, or Sockets, turns into thoſe Cavities being on one ſide contiguous to the Bone, and on the other to that fleſhy ſubſtance, which helps to faſten the Teeth more firmly, and where none of that hard fleſh intervenes, it does coaleſce with the Membrane, which does immediately cover that part of the Tooth, that lies within the Gums, and they make as it were but one Membrane.

There is one thing particularly remarkable in the Teeth, which other Bones do not ſeem to pretend to, and that is Nerves. The reaſon of the difference ſeems to be chiefly, if not ſolely for the ſake of that part, which is deſtitute of a Membrane: and to anſwer for the want of the *Perioſteum*. Though the deſign, and uſe of the Teeth would not admit of a Membrane in that part, which is immediately employed, and do act in Maſtication, yet it was neceſſary that ſhould have an influx of ſpirits to aſſiſt in its accretion, and nutrition, whereupon the Teeth have every one of them a Nerve, that ſupplies them to this part. The Nerve, which runs along in the Jaw, and from whence the Nerve of every particular Tooth is propagated, is plainly a *faſciculus* of other leſſer Nerves, which I have found to be more in ſome than in others. Sometimes they have been ſixteen, ſometimes twelve, and in a humane Jaw I once obſerved no more than ſeven. But all theſe ſmaller Nerves are diviſible into leſs, till at laſt they reſolve into minute Filaments. The *Foramina*, by which theſe Nerves paſs into the Tooth, are viſible with the help of a magnifying Glaſs, and many times without it, and there is always one to every Root, and in a Tooth which has had only a ſingle

Root I have met with two paſſages, one on each ſide, and the Foramen where it is ſingle is not always formed at the very extremity of the Root, but very often a little on one ſide.

The SECOND DISCOURSE OF ACCRETION, AND NUTRITION.

THE next thing, which I am to ſpeak of is the manner of the Bones Accretion, and Nutrition, which as indeed the growth, and nouriſhment of all the parts of the Body, are hard to be underſtood, and explained. That Accretion is by the addition or appoſition of new matter, and that Nutrition is a reparation of thoſe parts, which are continually expended, are accounts, that are eaſily given, and as eaſily underſtood. But how the nutritious Particles are ſeparated, and ſupply'd; how they are proportionally diſpenſed to all the ſolid parts of the Body, and regularly diſpoſed of; how Accretion is performed in young Animals till they grow to a convenient, and the ordinary magnitude of their own Kind, and comes to ceaſe after the dimenſions of the Animal are carried to the common and natural limits ſet to every Species, are not ſo eaſie to be explicated. However I have made ſome eſſays, and although ſome unlucky objection or other has made ſome thoughts I have had about this Argument miſcarry, yet I have formed and conſidered of one Hypotheſis, which gives me ſome ſatisfaction, and even the confidence to expoſe it to the objections, and to ſubmit it to the cenſure of greater Philoſophers, and better Judges.

To compleat an account of Accretion, and Nutrition, there are three things to be conſidered, and explained, the firſt is the manner how the nutritious matter is ſupplyed, and apponed to the parts of younger Animals ſo as to give an increaſe to their dimenſions. The ſecond is what it is, that puts a ſtop to this in a convenient time, or how it comes to paſs that Accretion ceaſes when the Animal is grown to a due magnitude, and the ordinary limits, that are preſcribed by Nature to the Species, which it is of. The third, and laſt thing to be enquired into is, what Nutrition taken ſtrictly is, and how it is performed: all which I ſhall do at large as it concerns all the parts in general, and then I deſign to give an account of the growth, and nouriſhment of the Bones in particular from the general Hypotheſis, which will lead me to the conſideration of ſome morbid affections of the ſeparts, where their nouriſhment is particularly concerned.

I ſhall not go about to mention, or object againſt the Philoſophy of others about theſe appearances, but only offer my own thoughts, and take my own method to explain them, only where any thing, that is plauſible, and ſtands in competition with my Hypotheſis, occurs, I ſhall be ſo natural as to endeavour the defence of what my own Thoughts have brought forth.

I ſhall begin firſt, and explain the manner how the parts in young Animals are nouriſhed ſo as to be extended in all their dimenſions. And firſt the nutritious Particles are ſupplyed from our daily Aliment, aſſuming after Concoction, and a due ſeparation of the purer from the more groſs, and feculent parts the form of Chyle, which through the Lacteal Veſſels paſſes into the Blood, taking in in its way a juice from the Lympheducts, in which there ſeem to be many of the luxuriant Particles of the *Succus nutritius* of the Glands, from whence they ariſe, which communicates ſome nutritive parts, and improves the nature of thoſe in the Chyle, which are deſigned for nouriſhment, and after this milky juice comes into the Blood, and arrives at the Heart, the parts, which are to make the nutritious juice, and are as yet imperfectly Concocted, are there ſo broken and attenuated, as to be adapted to the Pores, which are to ſeparate them from the Maſs of Blood; and diſpoſed for a ſeparation, after which they are conveyed by the Arteries to all the parts. That the nutritious juice is ſupplyed from the Maſs of Blood is ſuppoſed, and granted by the greateſt part both of Speculative Philoſophers, and Phyſicians, and therefore I need not trouble my ſelf much to prove it, or argue for it, only I mention this to give a more perfect account of what we are now concerned about, and to trace our nouriſhment from its firſt original. I know there are ſome would caſt this thing upon the Nerves, who plead the obſervation of an Atrophy, which often attends the parts, that are paralytick, to prove it. And I confeſs they have a plauſible Argument from it for their Opinion, and it may ſeem to preſs hard upon that, which is more commonly received, when they argue thus, that the part, which is affected with a Palſie is often imminiſhed, though there be a Pulſe, and an influx of

Blood into it. Now if the nutritious Juice be ſupplyed from the Maſs of Blood, how ſhould a part, that is paralitick want it, and decreaſe in any of its dimenſions, when the Blood, in which we conceive the *Succus nutritius* is contained, continues its influx into it. But an obſtruction of the Nerves we all allow in this caſe, and as the influx, and ſupply of the nutritious Juice is rationally to be ſuppoſed to be cut off by thoſe obſtructions, ſo we muſt conclude, that it naturally flows in thoſe Channels, where the obſtruction is made, that is in the Nerves. I ſhall not ſtand now to anſwer this Objection, but when I have offered my thoughts concerning the manner of Nutrition, I ſhall ſhew how according to my Hypotheſis an Atrophy may be the conſequence of a Palſie, though the nutritious Juice be naturally conveyed by the Arteries to the ſeveral parts, and with the other ſanguineous parts continues its circulatory courſe in the arterial Channels of that part, which is Paralytick, and labours at the ſame time with the ſymptom of an Atrophy.

Secondly, Though the nutritious Juice be contained in the Blood, and ſupplyed from it, it is not the whole Maſs of Blood, nor any portion of it indifferently that is fit to be united to, and to give an increaſe to any parts of the Body; but they are a peculiar ſort of

Particles, that are every where diſpenſed for this end, ſuch as will form a ſubſtance of the ſame nature, which the part, that they augment is of. And this Juice not only is different from other humours, both thoſe that are excrementitious, and ſuch as are otherways uſeful, but we have ſome reaſon to think that there is a difference even in the *ſuccus nutritius* it ſelf. For where the Nature, and Conſtitution of one part are remarkably diverſe from them of another, as in the Bones, and Fibres, there the nutritious Particles ſeem likewiſe to be different.

How far the difference lies between the muſcular, membranous, and vaſcular parts I leave to others to inquire, to better, and nicer judgments to determine. Though I cannot but ſay I do conceive that there is no difference in the *ſuccus nutritius* of theſe parts, only in the manner or order, in which the Particles of it are diſpoſed in their appoſition, ſince, as it is commonly known, in Iſſues and about the edges of them, the nutritious Juice of the Skin does often produce fleſhy Excreſcencies, ſuch a Fleſh as is different from the nature of the part, which it is to nouriſh. And although the Excreſcence from thence made be different from the Skin, yet it is certain that it is from the *ſuccus nutritius* of the *cutis*, ſince the *ſolutio continui* is made in that part, upon which the nouriſhment after it is ſeparated by the nutritious Glandules extravaſates, and by ſticking round the edges of thoſe *Foramina*, by which it iſſues out lays the Foundation, and by the gradual addition of it ſelf raiſes the Structure of thoſe Excreſcencies. It cannot be thought to be the nouriſhment of the fleſhy parts diſtinct from that of the *cutis*, for the wound inflicted does not reach ſo deep as to ſet open the *Canaliculi* of the fleſhy Fibres, and to give a preternatural paſſage to their nutritious parts; but in Men there intervenes the *Membrana adipoſa* between the *cutis*, and any thing of Fleſh, excepting in the Lips, and two or three placs more.

Be there a difference, or not it is always gelatinous, and this not only our reaſon perſuades us, as it is requiſite it ſhould be ſo to diſpoſe it to adhere and unite to the parts, but there is that ſometimes, which ſeems to demonſtrate it to our very ſenſes, I mean in Ganglions, where the material cauſe of the Tumor is rather the nutritious Juice of the nervous or tendinous parts extravaſated than any preternatural humour, or matter. For although I do not ſuppoſe that the *ſuccus nutritius* of the Body is from the Nerves; yet they have as other parts a ſupply of it for their own nouriſhment, which I take to be all the *ſuccus nervoſus* that they have. Now the matter, which is collected in theſe ſwellings is always a ſort of Gelly, which may help to inform us what the nature of the nutritious Juice is.

Thirdly, The Particles, which ſerve for nouriſhment are ſeparated from the reſt of the Maſs of Blood before they can aſſume the diſtinct, and propet form of a nutritious Juice, or be employed in the augmentation of the parts. For if we ſuppoſe that they are ſupplyed and caſt upon the parts immediately by the Blood circulating through them, if we imagine, according to *Diemerbroek*'s notion, that the nutritious Particles as being a part of the ſanguineous Maſs and circulating through the whole Body, are by the power of their motion driven againſt the ſides of the Veſſels, which contain that Maſs of Blood, and ſtriking into the Pores ſtick there, and as one end of the Particles thus driven in fills them, ſo the other extremity, which ſtands out forms another Series of new Pores for the infixation, and unition of new parts: I ſay, if we take up with this Hypotheſis, then we muſt make the Blood immediately to waſh every part that is nouriſhed, ſo that either Nutrition muſt be monopolized by the Veins and Arteries, or we muſt grant an extravaſation of the Blood ſo as to touch upon every ſingle Fibre, that is nouriſhed, in its circulation, which will be to make the whole Body to conſiſt of nothing but ſanguiferous ducts, beſides other Objections, which I ſhall not ſtand to mention.

Fourthly, This ſeparation of the nutritious Juice is made by Glandules or glandular Pores, which may properly enough be termed Glandules, as they ſerve for the ſame Office, to wit, Secretion. Theſe nutritious Glandules we cannot ſuppoſe to be generally placed at the extremities of the Arteries. For, beſides that we cannot upon this ſuppoſition conceive how every Fibre, and every part of that Fibre can have the nutritious parts ſupplyed to it, it is impoſſible it ſhould be ſo in the Glands, where the extremities of the Arteries are occupyed by Glandules of another nature, that ſeparate another kind of liquor, and ſuch as is evidently not deſigned for the nouriſhment of thoſe parts, as to inſtance only in the Kidneys, it is plain that at the extremities of the arterial Veſſels in theſe Glands are placed the Glandules, which ſerve for the ſeparation of the urinary *Serum*, ſo that there is no convenience for the ſituation of other diſtinct Glandules, and thoſe which are there ſeated being the colatory parts, that ſeparate an excrementitious humour, cannot be thought to be the Organs, that ſeparate and ſupply the matter, that nouriſhes them. Therefore I do conceive, and I think not without very good reaſon, that there are Glandules, or particular Pores adapted to the figure of the nutritious parts, which are to paſs through them formed in the ſides of the Arteries, every where as they proceed, almoſt in the ſame manner as the Glandules are ſeated in the ſmall Inteſtines, by which the Chyle is ſeparated from the *Fæces*, and penetrates the Guts into the lacteal Veſſels, only there is this difference that the lacteal Glandules are planted along the ſmall Guts but on one ſide of the Canale, whereas thoſe, that ſerve for Accretion, and Nutrition are ſeated on every ſide of the arterial Channel, and ſupply a *ſuccus nutritius* to all the Fibres and other parts which lie immediately round about, or very nigh to them. Now as we cannot ſuppoſe that any of theſe Glandules are ſeated at the extremities of the Arteries in any of the Glands of the Body, ſo the ſituation I aſcribe to them, makes them conſiſtent with other Glandules in the ſame Artery, ſo that we may eaſily apprehend how the ſame Arteries which ſerve to the Glandules, that ſeparate the particular humour of that Gland, ſerve alſo for the ſupply of that Juice, which nouriſhes it, as it is made no matter of doubt but they are the ſame. And not only ſo, but this ſituation is more convenient for the ſeparation, and ſupply of the *ſuccus nutritius*

tritius to the whole Body, if it be not that, which only can anſwer this deſign of Nature.

And now I am ſpeaking of the ſeparation of theſe Particles, pardon the digreſſion, if I ſuffer my ſelf to be led a little by this occaſion out of the propoſed method of my Diſcourſe to conſider the manner, in which glandular Secretion is performed, which being explained, will help us to underſtand how not only this, but all the humours, which Nature extracts from the Maſs of Blood, are ſeparated.

It is true there is a diverſity in all Glands, that ſeparate a different Liquor, but yet there are ſeveral general things, in which they all agree, ſo far as their Office is Secretion without a reſpect to the particular Liquors, which they ſecern.

To what I am going to ſay concerning this great affair of Nature, I muſt premiſe that natural Law of Motion, that all Motion in its own Nature, or proper tendency is direct from its Centre, or *terminus à quo*, or to uſe the great Philoſopher *Des-Cartes*'s own words ſpeaking of Motion, *Altera lex Naturæ eſt; unamquamque partem materiæ ſeorſim ſpectatam non tendere unquam, ut ſecundum ullas lineas obliquas pergat moveri, ſed tantummodo ſecundum rectas*; and that it never does but from ſome oppoſition, and the occurrence of another Body either fixed, or differently moving incline to an obliquity, and even every Body that is moved circularly, does endeavor to recede from the Centre of that Circle, which it deſcribes. And although when a ſolid Body being in motion meets with another, which has a greater power to ſtop it, than that has to perſiſt, it is reverberated; yet there are ſome Bodies, which are not in their own Nature ſo fit, and ready to be reflected, as thoſe, which are viſcous, ſoft, or fluid, and be they ſolid or not, yet when there is a continuation of matter, which from the *terminus à quo* preſſes them on with a greater force than what they have to recede with, ſo long they will not be reflected, though there lies a reſiſtent Body in the way of their direct Motion, but if there are any lateral and oblique paſſages they will continue to move on that way, which offers it ſelf faireſt for, and comes neareſt to the line of their direct motion.

Now for the particulars, wherein the general agreement between all Glands lies they may be reduced to theſe Heads.

Firſt, All Glands have their *Vaſa Adferentia*, or Veſſels to convey to them that Maſs from which the Particles, or that particular humour, which they ſeparate, is extracted. Theſe Veſſels in thoſe Glands, which ſeparate any humour from the ſanguineous Maſs, are commonly Arteries, though it cannot be affirmed that they are always ſo. For in the Liver it is known that the bilious Juice is conveyed in the Maſs of Blood to the Hepatick Glandules by Veins, the *Vena Portæ*, and the branches of it, which belong (to uſe the old term) to the *Parenchyma* of that large *Viſcus*. But generally they are of the arterial kind, and ſuch are the Veſſels, which carry the Blood and the nouriſhing parts contained in it to the nutritious Glandules, only in the part I now mentioned, as the *Vena Portæ* does perform the Office of an Artery to the Hepatick Glandules, ſo I do conceive it has the ſame ſort of nutritious Glandules, as the Arteries every where have, formed in the ſides of it.

Secondly, To theſe Veſſels, be they Veins, or Arteries, belong ſmall Glandules or ſecretory Organs, which ſeem to be formed from the exterior Tunicle of the *Vaſa adferentia* expanded, and in a peculiar manner modified, and that the *Vena Portæ* might have a Tunicle to ſpare for this end, it has a Coat extraordinary, immediately communicated from the Membrane, which cloaths the Liver. From hence we may have the reaſon, why the Veins have fewer Coats than an Artery, becauſe, where the one terminates, and the other ariſe, there is one Tunicle taken off for the formation of the Glandules, which for the moſt part are placed at the extremities of the *Vaſa adferentia,* whether they are Arteries or Veins, yet not ſo univerſally but that where it is more convenient, or rather neceſſary for accompliſhing the ends, for which the Juice is deſigned, they are ſeated on the ſides of theſe Veſſels, as thoſe that ſerve for Accretion, and Nutrition. They are always ſo ſeated as to be expoſed to the appulſe of the Blood, that like a ſhoar they have the Waves of this Red Sea continually beating upon them, and they ſtand ſo as to favour the motion of the Particles, that they are to ſecern, and their tendency in a right line, at leaſt more than the Veſſels, which the reſiduous Maſs continues its courſe into. This is evidently ſo in thoſe Glands, in which the Glandules are ſeated at the extremities of the *Vaſa adferentia.* For as ſoon as the Blood is arrived at thoſe extremities it is reflected, the Veſſels, through which it is afterwards to continue its motion, run commonly directly contrary to the courſe, which it held in the Veſſels, that convey it to the Glandules. So that when the Blood is come to the extremities of the *Vaſa adferentia,* the motion of it afterwards, and its progreſſion into the venoſe Veſſels, which convey it back to the Heart, do not anſwer to its natural tendency; whereas the Glandules are conveniently ſituated for favouring the direct motion of the Particles, which they are to ſeparate, and thereupon the Particles of the Liquor, which they ſecern, do naturally or in obedience to that Law of Motion, reſpecting its tendency, which I firſt mentioned, preſs upon them, and endeavour to proceed into them. And how this aſſertion, that the ſituation of the Glandules is ſo contrived, and ordered as to favour the tendency of that matter, which they ſecern, more than the Veſſels, which carry the Blood back to the Heart, I ſay how this holds true in the *Glandulæ Nutritiæ,* I ſhall preſently ſhew.

Thirdly, Theſe Glandules have Pores or Paſſages, by which they receive the Particles, which they are appointed to ſeparate. In this all Glands do neceſſarily agree that their Glandules are perforated on that ſide where the Blood beats directly upon them, which Perforation is their ſecretory Pore. Beſides which they have another, whereby they diſcharge and empty themſelves commonly into Ducts, which meet in one common Receptacle. Tho there are ſome Glandules, that ſeem to evacuate themſelves by their exoneratory Pore into the Maſs of Blood.

Fourthly, at the termination of thoſe glandular Pores, by which the parts of the Liquor produced by every Gland are ſeparated, or on that ſide, which lies next to the ſmall

Cavity of the Glandules there ſeem to be Valves or ſuch a Formation as is equivalent to them. For although the Glandules themſelves are ſo ſeated, that the Particles, which are ſeparated by them, when they ſtrike againſt them and the paſſages are clear; and obtain their natural figure, cannot but in obedience to that natural Law of Motion, I have taken notice of, advance into them; yet we find that the particular Ducts leading from the Glandules, to the Receptacles, or any large conveyances, run in ſeveral Glands plainly contrary to the courſe of the Arteries, ſo as ſometimes to make a ſociable progreſs with the Veins, at leaſt for ſome way: ſo that the courſe of theſe Ducts is as contrary to the natural tendency of the Particles, which they convey, as that of the Veins is, as to inſtance again in the Kidneys, there autopſie it ſelf does tell us that the *Tubuli urinarii*, which carry the Urine to the *Pelvis*, after it is ſeparated by the *Glandulæ Renales*, run as contrary to courſe of the Arteries, and the tendency of the urinary *ſerum*, whilſt it is moving through thoſe Arteries with the other parts of the ſanguineous Maſs, as the Venoſe Veſſels do. And therefore when the Particles that are admitted, and ſeparated by the glandular Pores, are once entered into the Glandules, they have no farther to go in a line more direct, and agreeable to their tendency, than if they were carried into the Veins; but the tendency of their motion muſt neceſſarily be altered by the variation in the courſe of thoſe Ducts, and being obliged to a reflection ſome of them might regurgitate into the Artery, if there were not *Valves*, or ſuch a contrivance in the ſecretory Pores as not only makes them capable of giving the Particles they are to ſeparate leave to enter, but denies them likewiſe the liberty of returning.

I know there is one thing may be objected againſt it, to prove that it is not neceſſary there ſhould be *Valves* or any thing like them, and that is that the continual ſucceſſion, and impulſe of new matter is a ſufficient proviſion againſt the regurgitation of any Liquor or Particles of it into the Blood by thoſe glandular Pores, which had before ſeparated them. For the Particles which are already ſeparated, ſeem to be obliged to proceed from the Glandule into the Duct, from the continual preſſure, and protruſion of thoſe parts, which come immediately after them.

But Secretion being the grand affair of Nature, upon which not only our Health, and Well-being as we are Animals, but our very Lives do depend, it muſt be thought in a buſineſs of ſo much importance ſhe has taken care for carrying on that great and neceſſary Work by giving the part, in which it is to be performed, all the advantages in its Structure, which it is capable of: eſpecially when we conſider that though there is in the Veins, and Lymphatick Veſſels the ſame reaſon to make ſuch a contrivance unneceſſary, though there is the continual influx, and ſucceſſion of the humours, which they convey, to propel any parts of that matter, which had before entered into, and are moving in the Channels of thoſe Veſſels; yet we find that they have their *Valves* to hinder the regurgitation, or reflux of the Blood, and *Lympha* in them, and to promote their progreſſive Motion or Circulation, and that even where they are ſtreight, and there is nothing in their courſe to alter the tendency of the humours, and to diſpoſe them to a reflection. Nay, even in the Heart at thoſe paſſages into the *Arteria Pulmonaris*, and the *Aorta*, where the preſſure of the ſubſequent Blood upon that, which flows immediately before it, is more violent than in any other part of the Body: Nature has not thought the ſucceſſion of one part of it to another, and the power, which one has to propel the other, an infallible remedy againſt the reflux of that, which is already thrown into thoſe Veſſels; but to make the progreſſion of it more certain, and neceſſary, has planted at the paſſage out of the Ventricles thoſe ſtrong, and remarkable *Valves* which we call *Semilunares*. How then can we think that the Glands, which ſerve (eſpecially ſome of them) for great, and neceſſary uſes, that ſtand at a greater diſtance from the Heart, and conſequently have a leſs violent appulſe of the Blood, and where one part of the Liquor, which they ſeparate, make a more languid preſſure upon another, ſhould be deſtitute of this advantage?

Fifthly, and laſtly, To the Glands belong alſo Blood-Veſſels deſigned for carrying off, and conveying back to the Heart that part of the Blood, which had not the liberty to enter into their Glandules.

The impediment, which hinders the progreſs of thoſe parts of the Blood, that return by theſe Veſſels, into the Glandules, is twofold, one is neceſſary, the other contingent. That which is neceſſary lies againſt thoſe Particles, which are not in their figure adapted to the glandular Pores, or are of ſuch a magnitude as renders them uncapable of entring into them: That which is accidental prevents the ingreſs of many of thoſe Particles into the Glandules, which are both in figure and magnitude adapted to their Pores, and of the ſame nature as thoſe, which at the ſame time are ſeparated by them. Where it is not becauſe the Glandules in themſelves are uncapable of admitting them, that they paſs by them into the reducent Veſſels, but from the anticipation of other Particles of the ſame kind occupying the mouths or Pores of the Glandules in that inſtant, when they are ready to enter. For the Blood being naturally in the hurry of a rapid motion there is no ſuch thing as ſtopping or expectation in the Artery. So that it is impoſſible but ſome Particles ſhould ſlip by the Glandules, which ought to ſeparate them, whilſt others are in the paſſages. And hence partly it comes to paſs that the Blood after ſo many Circulations, and the Secretions performed in thoſe Circulations does ſtill ſupply to all the Glands thoſe Particles, which they naturally ſecern without a continued ſucceſſion of Chyle; as partly from the comminution of ſome parts, whoſe magnitude before they are farther attenuated by the Heart and Spirits, renders them uncapable of penetrating the glandular Pores.

The Veſſels, which carry off the reſiduous Blood in the *Viſcera*, and other Glands, after it has paid a Tribute to them, are the Veins, and the ſame kind of Veſſels do perform this Office to the nutritious Glandules, but not ſo immediately. For they not being ſeated at the extremities; but in the ſides of the Arteries, the Blood does not ſo ſoon as it has ſupplyed ſome of the nutritious Particles to the Glandules, preſently ſhift its Veſſels, and flow into the Veins, but continues its courſe in the Artery afterwards. So that it is the Artery, that does immediately convey the Blood from theſe Glands, unleſs there are any of them placed at the extremities of the Arteries in ſome parts, as it is probable there are in the Nerves, and Muſcular parts, and in the ſubſtance of the Bones, where thoſe extremities do not ſeem to be occupyed by other Glandules. But yet at laſt the Blood, when it has paſſed by all the nutritious Glandules in an Artery, is received, and carryed away by the Veins.

From what I have ſaid concerning the general agreement of all Glands in their Structure, and the Veſſels belonging to them, and the Law whereby all Bodies, that are moved, are directed in their natural tendency, we ſhall find it no difficult thing to conceive how all the humours of the ſeveral Glands are ſeparated, and to explain the manner of glandular Secretion. As for that ſeparation, which is made by the Glandules of the *Viſcera*, and wherever they are ſeated at the extremities of the *Vaſa Adſerentia*, there is this account may be given of it, to wit, that the Blood being carryed with a quick, and violent motion to the extremities of thoſe Veſſels, which ſupply it to the Glands, all the parts of it are there endeavouring to proceed in a right line, and with this endeavour they neceſſarily preſs upon the ſecretory Organs, which are there placed, which being ſeated in the way of their motion, and ſo as to favour their tendency in a more ſtreight line than the Veins, which run contrary to it, they are continually importuned by their preſſure to entertain them, and all the Particles of the Blood, if they could have the liberty of continuing their motion in that line, which they endeavour to proceed in, would more readily proceed into the Pores of the Glandules, than be reflected into the Veins. But although there is an appulſe, and a preſſure of all ſorts of Particles in the Blood againſt theſe Glandules, it is not poſſible they ſhould all of them continue their motion into them, ſo long as the Glandules injoy their natural tone, and their Pores obtain their proper figure; they are only thoſe, which have ſuch a figure, as adapts them to the ſecretory Pores, and are of ſuch a magnitude as makes them capable of penetrating them, that can be admitted, and theſe are the Particles, o which the humour that is naturally ſeparated by every particular Gland, does conſiſt, whilſ others, that are differently figurated, and ſome of thoſe, which are capable of entring the glandular Pores, being hindered by more forward Particles are hurried into the Veins.

Whe

When I make the adaptation of the figure, and magnitude of the parts, which are to be ſeparated, to thoſe Pores of the Glandules, which ſecern them, to be the great reaſon why they have a free paſſage into them, when ſome others are neceſſarily excluded, and why every Gland is ſo conſtant in the ſeparation of its proper, and natural humour, ſome may be ready to object that there are Particles of a different figure ſeparated by every Gland, ſo through the glandular Pores in the Kidneys do paſs both aqueous, and ſaline, and through thoſe of the Liver, beſides ſalt, and aqueous Particles, ſome, which are of a ſulphureous nature, and ſo in others. And ſince it muſt be granted that the Particles of all theſe Principles are of a different figure, we cannot ſuppoſe the adaptation of their figure to that of the Pores to be the reaſon why every Gland does ſecern ſuch or ſuch a humour, when it is impoſſible that the figure of more than one ſhould correſpond to it; and therefore we muſt allow ſomething of a ferment to precipitate it, and to give it its peculiar Nature. To this it may be anſwered that it is not here ſuppoſed that the Pores of the Glandules are agreeable in their figure to the Particles of any one pure Principle, whether it be Salt, Sulphur, or any of the reſt, ſince there are none of theſe to be found ſincere, but the

Particles ſeparable through the Pores of any particular Glandules, are, as I have already ſaid of the Conſtituent parts of a Bone, a compoſition of two, or more of thoſe, which we call Principles, and from their proportion, and the manner of their union in a Particle does ariſe the form, which accommodates it to the figure of the Pore, which it is to penetrate. And do we not find that there is ſuch an agreement, and ſuch an aptitude in ſome of them, which we call Principles (and which perhaps may be yet more ſimple, and fewer, than we ſuppoſe them) to unite, that all the power of the Fire, and the tricks of the Chymiſts could never ſeparate any one of them ſo that they could pretend to exhibit it ſincere.

But to come to the nutritious Glandules, which it does more properly concern us to ſpeak of at this time, I have ſuppoſed that in their ſituation they are different from all others, that ſeparate any Juice or humour from the Maſs of Blood, that whereas others are placed at the extremities of the Veſſels, which convey the Blood to them, theſe are ſeated on the ſides of thoſe Veſſels. I did likewiſe obſerve that there is ſomething like their ſituation in the Lacteal Glands of the ſmall Inteſtines, where all the Pulpe of our digeſted Food, eſpecially in the *Jejunum*, and the *Ileon* paſſes from one Glandule to another ſucceſſively, and yields the ſame ſort of Liquor to ſeveral Glandules in the ſame Canale, as it is reaſonable to think that the Blood ſupplies the nutritious Juice to ſeveral glandular Pores in every ſingle twig of an Artery.

Though this ſituation of the nutritious Glandules be different from almoſt all others, yet is it not irregular. For if we conſider how ready they ſtand in this poſition for receiving thoſe Particles, which they are to ſeparate, and for the continuation of their direct motion, I do not ſee if their uſe would have admitted of it, and they had been diſpoſed in the manner and order of the Glandules of the *Viſcera*, that they would have been placed more conveniently for the performance of their Office of Secretion, than now they are. Neither is that propoſition I laid down that the Glandules are ſo ſeated as to favour the tendency of the Particles, which they ſecern, and their direct motion, at leaſt more than the Veins contradicted by the ſituation of theſe. Nay, it is ſo far from this, that it is demonſtrable they are more advantageouſly placed, and ſo ſeated as to give the Particles, which they are to entertain, leave to move forward in a more ſtreight line than thoſe, which are ſeated at the extremities of the *Vaſa Adferentia* do. For the motion into them is from ſome part of the arterial Channel, though we ſuppoſe it to be a ſingle ſtreight twig, more direct than to the extremity of that Artery. This will evidently appear to be ſo, if we conſider how the Arteries as they proceed are contracted, and grow leſs, and leſs, for if a ſtreight line were to be drawn from ſome part of the arterial Channel, where it is large, to begin at a little diſtance from any one ſide of it, and to run that way, which the Artery tends, it would, after it was carried a little way, run through the Coats, or that ſide of the Artery, which it is next to. So that whatever moves forward near the ſide of the Artery, where it is more large, muſt neceſſarily, when it advances forward to that part, where the Artery is ſo contracted, that the ſide of it is drawn into the place, where the ſtreight line of that matters motion runs, there I ſay it muſt neceſſarily ſtrike upon, and preſs againſt that part of it. So that if it meets there with a free and convenient paſſage, it does more naturally proceed into that Pore, than paſs on farther in the arterial Channel, where it is put ſomewhat out of its direct Road, and obliged to an oblique motion. As ſuppoſe in the ſecond figure Tab. 1. *a, a, a*, to be an Artery gradually contracted, as it proceeds towards *b.* and the Particles of the Blood *c, c.* to be moving in it from the contrary extremity, when any of theſe Particles are advanced in the Artery as far as *d, d.* the line of their direct motion does not run towards *b.* but on in the lines *e, e.* towards *f.* ſo that their endeavour will be to proceed in thoſe lines, and they will neceſſarily make a preſſure upon the ſides of the Artery at *d, d.* Beſides, that the Blood does thus ſtrike againſt the ſides of the Arteries, and that with a force ſufficient to carry any Particles of it through, and beyond the Coats of thoſe Veſſels, if there only be paſſages agreeable to the figure, and magnitude of any of them, is evident to our Senſes in the Pulſe, and the violent eruption of the Blood, when any one of them is pricked.

The Particles therefore, which are deſigned for nouriſhment, being carried by the motion impreſt upon them, and their natural tendency whilſt they are in motion, with the other parts of the Blood againſt the ſides of the Arteries, preſſing upon them, and finding Pores convenient particularly for their paſſage, and the continuation of their motion in a right line, do proceed into them, leaving the reſt of the Maſs of Blood to continue its courſe in the Artery, and out of that into the Venoſe Channel. And having entred the nutritious Glandules they are preſſed forward by every ſyſtole of the Artery as the contraction or ſubſidence of it renders the glandular Cavities placed in the ſides of it more narrow, and perhaps by a power of contraction, which may be in the Glandules themſelves; and they are propelled by Particles of the ſame nature coming behind them in every Diaſtole of the ſame Veſſel, till they are driven into the Interſtices of the Fibres, of the bony Strings, and every other part, where the Spirits move, where it is evident that they will lie in the way of the Spirits motion, and then they come to be more immediately employed in the Accretion of young Animals.

From the ſuppoſition of theſe nutritious Glandules, and the manner in which the *ſuccus nutritius* is ſupplyed to all the parts, as I have explained it, I might give ſome probable account of an *Anaſarca*, and the manner how it is produced, but I muſt conſider I have been already a Tranſgreſſour, and deviated too much from my Argument, ſo that I muſt expect ſome other opportunity to ſpeak of that.

For the better underſtanding how the nutritious Particles are managed, when they are ſeparated by theſe Glandules, and thrown into the way of the Spirits motion, I ſhall lay down theſe following propoſitions.

Firſt, That as the Spirits have a direct motion *à termino ad terminum*, ſo have they a circular or rotatory motion turning round their own Centers. Neither do I ſuppoſe a rotatory as well as a direct motion in the Spirits merely to ſerve my preſent purpoſe, and without any other reaſon, than that I may accommodate their motion to my Hypotheſis, but if we conſider the Spirits ſimply in themſelves, and without any reſpect to the part, that they act in our nouriſhment, we cannot think otherwiſe than that they do *rotare* in the line of their direct motion, when we find in the projection of a Stone out of our hands, or out of a Sling that it turns round as it moves forward. And to inſtance in ſome things, to which the nature of the Spirits ſeems to have a very near acceſs, as Fire and the Rays of the Sun, do not the *Scintillulæ* ſtruck off from a Flint plainly move round their own Centers? Do not ſome effects of Fire, and the Rays of the Sun diſcover more than one ſingle, or a direct motion in their Particles? For how can we conceive that they ſhould inkindle combuſtible Bodies, that are ſolid, and melt the moſt obdurate Metals, diſunite their parts, and diſſolve their texture merely by a direct preſſure, which without ſuch a violent rotation of the fiery Particles as diſtracts, and moves the Particles of the Body, which is melted or ſet on fire, ſome one way, and ſome another, would propel or elevate the whole *Moles* of the ſolid Body at the ſame time without diſturbing the order, or altering the ſituation of thoſe parts of it, which are fixed, and united. But I think I need not inſiſt upon any argument to prove a twofold motion in fiery Particles, when the notion, which Philoſophers now generally have of the nature of Fire, may ſave me the trouble of arguing for that, which I would here ſuppoſe. Which being granted may go very far to perſuade us, that there is the ſame variety of motion in the Spirits.

Secondly, The Spirits will endeavour to remove whatever lies in the way of their motion. What Body ſo ever is moved, as it has a natural *conatus* to perſiſt, ſo it will offer violence to any thing, that lies as an obſtacle before it, proportionable to the power of its motion, endeavouring either to drive it forward, and to make it comply with its own ſtreight tendency, when the impreſſion is direct, or to divert, and caſt it off to one ſide of that line, in which it moves, which is done when the impreſſion is more lateral, or the Body moving acts upon that, which is moved, by a rotatory motion.

Thirdly, The Spirits by the power of their circulatory Motion or Rotation will carry the nutritious Particles to one ſide of that line in which they move, if there either actually are ſpaces to entertain them, or any can be forcibly obtained by the power of that motion, which determines them thither; I ſay the

Spirit

Spirits will rather carry them thus laterally, than give them a direct tendency, ſince the *ſuccus nutritius* is liquid, and gelatinous, and the parts of it not ſo fit to maintain a direct motion, but apt to adhere, that when the Spirits impinge againſt them, and when the nutritious Particles apply themſelves to the Spirits, they will certainly move circularly with that part, which they ſtick to. But the Interſtices of the nervous Fibres, and of the Strings of other parts being repleted with Spirits, it is plain that the nutritious parts, when they are by the Spirits Rotation carried to any ſide of thoſe Interſtices, between which and the Spirits there is no diſtance or vacuity, will have ſome ſtop, ſo that they adhere there, and are not able to proceed any farther in that Circle, in which they were moving. Suppoſe a Bowl running upon the ground, and the moſt forward part as it is in motion meets with, and ſtrikes upon any matter, that is viſcous, the matter adhering to it will turn with it, and ſo that, and the part, which it ſticks to, will be both in their Circulation brought to the ground at the ſame time, and the Bowl running cloſe to the ground, though it has nothing to confine it, and neceſſarily to keep it down on the other ſide, does not carry all the matter quite round, but preſſing it againſt the Earth leaves ſome part of it ſticking behind, whilſt the Bowl it ſelf proceeds. Suppoſe it were a Body, that were not viſcous, only it is not ſo ſolid as to be reverberated by it, as a piece of Cotton, Wool, Cloath, or any ſuch thing, we find it does not receive ſo much a direct motion from that of the Bowl, which is ſo, as a lateral from its Rotation, ſo that if any thing of their nature occurs, the Bowl in turning will drive it towards the Ground, which is to one ſide of its direct motion. And indeed when the power of a rotatory motion in one Body acts upon another, that is truly ſolid, the natural tendency of that, which receives the impreſſion, is not directly forward from that part of the Body, from which it received it, but lateral.

Fourthly, Whilſt the Animal is young, and tender, the tone of the parts is more lax, the Fibres are more tenſile, ſo that in any intermediate part between their extremities they are capable of yielding to a preſſure, and receding laterally, and whilſt the Particles are not yet united they are in a capacity of being removed and ſet at ſome diſtance one from the other by the inſinuation of any new matter between them: And thus the bony parts, whilſt they are ſoft, and cartilaginous, are in ſuch a ſtate, that the Particles of one ſeries can be moved laterally from them of another, and thoſe of the ſame ſeries are capable of receding from one another at their extremities.

Fifthly, the ſame power of the Spirits Rotation, that carries the nutritious matter to the ſides of the Fibrils, of the Strings of the Bones, or any other part, will by crowding this matter againſt them, oblige their Particles to recede laterally, and by driving it into the Interſtices between the extremities of the Particles ſet their extremities at a greater diſtance from one another.

I ſhall now ſee how far, and fairly we may be able with theſe propoſitions to ſolve the *Phænomenon* of Accretion, and give a particular, and ſummary account of the manner, how it is performed. The nutritious Particles therefore being ſeparated from the Maſs of Blood by their proper Glandules, and carryed into the Interſtices of the fibrous Threads, and of the Strings of the Bones, come under the diſpoſal of the Spirits, and the power and influence of their motion. And were there not ſuch an active Principle to give a motion to the Particles of the nutritious Juice, and to diſpoſe of them, to preſerve the Interſtices, into which they flow, free from thoſe obſtructions, which a matter of ſuch a gelatinous, and viſcous nature as renders it uncapable of diffuſing it ſelf freely, and being otherwiſe equally diſtributed to all the parts of a Fibril, or bony String, would be apt to create, how ſoon would they clog, and obſtruct the Interſtices, and intercept the nouriſhment, which is neceſſary for the increaſe of that part, which lies beyond the obſtruction, and ought to have a ſupply of the *ſuccus nutritius* from that Glandule, whoſe ſecreted Juice did firſt produce the obſtruction? So then the Spirits in their paſſage meeting with the nutritious Particles lying in the way of their motion, will naturally endeavour to remove them by a preſſure ariſing from that, which is natural to all Bodies, that are put into motion, a diſpoſition, and a *conatus* to perſiſt in it.

There ſeem to be two ways, which the Spirits have, as they have a twofold motion, to clear their Road, and to prevent the interruption of their flux, and the alteration of their tendency, one is by communicating a direct motion to the Particles, which lie in their way, and ſuch a degree of it as ſhall make them move with an equal velocity, which muſt be done by that, which in themſelves has a direct tendency, or elſe by driving them laterally, by working, and winding them to one ſide of that line, in which they move, which is done by their Rotation. But whilſt the Fibrils, and bony Strings are capable of receding, and giving way to the preſſure of the nutritious Juice, the Spirits muſt neceſſarily act upon it by their Rotation, as it is gelatinous, and of an adhering quality, ſo that they muſt carry it to the ſides of the Interſtices, in which they move, and drive it upon the minute Fibres, between which thoſe Interſtices are formed. But ſuppoſing the Spirits could at this time act upon it by their direct as well as their rotatory motion, this would not neceſſarily divert, or keep off the nutritious Juice from the Fibres, which lie on one ſide the line of their direct motion. For although a Body moving in a ſtreight line will make ſuch an impreſſion upon another, that lies in the way of its tendency, as ſhall transfer a direct motion to it; yet the incidence of one may be ſuch, and it may in ſuch a manner impinge againſt the other, as to communicate a lateral motion to it by that, which in it ſelf is direct.

But then there muſt be room to lodge this nutritious matter in, that the Rotation of the Spirits may be able to carry, and fix it on one ſide of the line of their direct motion. For if it could not do this, but the nouriſhing Juice lay always under the power and preſſure of their direct motion, it muſt neceſſarily be diſturbed, and driven along in the Interſtices, in which they move, ſo that it could never have leave to fix upon their ſides, and unite. As for the ſpace therefore, or vacuity, which is requiſite to this end, though there is no place actually void before the *ſuccus nutritius* is driven upon the fibrous Threads, and bony Strings, becauſe the Spirits fill the ſmall Channels, in which they are moving, yet it is obtained both in the Bones, and Fibres, as in all other parts by that force, with which the nutritious Particles are driven upon them. For whilſt the Animal is young the Bones are ſoft, the fibrous parts are very tender, and the Particles of which they conſiſt not ſo entirely, and firmly united, as they afterwards appear to be. So that the nutritious matter crowded againſt them by the Rotation of the Spirits does extrude them laterally, and taking poſſeſſion of that room, which the preſſure of it makes, does adhere to the ſides of them, and ſo makes an addition to their craſſitude. And as it thruſts them out laterally, ſo that part of the nutritious matter, which is carried by the ſame Rotation of the Spirits to the Interſtices, which are between the extremities of the Particles, of which the parts conſiſt, being driven in like a wedge, it cauſes them inſenſibly to recede, and ſets the extremity of one Particle at a greater diſtance from another, (yet by ſuch inſenſible degrees, and in ſuch a manner that the continuity of the part is ſtill preſerved) ſo that the line, which they lie in, will be extended, and every Series of them elongated, where the nutritious matter fixing, being united, and becoming a ſubſtance of the ſame nature as the part is of, which it gives an increaſe to, adds to the length of it. Thus the Spirits ſo long as the Particles of the Bones, and other parts are capable of receding, and will make room to entertain the nutritive parts out of the way of their direct motion, will drive them upon the ſides of the bony, and fibrous Strings, and by that preſſure oblige them to recede, where the *ſuccus nutritius* not only has time, and liberty to adhere to them, but by the Spirits Rotation as they continually paſs by is kept cloſe and contiguous to the parts, until it is more firmly united, and as the nouriſhing Particles, that are once lodged there, are crowded nearer to one another by thoſe, which are afterwards ſupplyed, and as it were knocked cloſer together by the rotatory motion of the Spirits, the matter contracts a ſolidity, and at laſt aſſumes the nature of the part, which it nouriſhes.

Thus are performed the ſeparation, the diſpenſation, and diſpoſal, and laſtly the union of the nutritive parts to thoſe of the Body, which they augment. So that I have finiſhed that part of this Diſcourſe, which concerns Accretion ſo long as it proceeds, I ſhall only obſerve how reaſonable it is to think that the gelatinous nature, the viſcoſity of the *ſuccus nutritius*, and its coming in the way of the Spirits motion do retund the violence,

lence, and quickneſs of it, and conſequently temper that heat, which the Spirits continually maintain; and that the Hectical heats, which attend Conſumptions, and often follow upon great evacuations, are from the want of this gelatinous Matter to lie in their way, to check, and balance that violence, and velocity, with which they move.

But I paſs on to the ſecond thing to be conſidered, which is the reaſon of the limits of an Animal's growth, and what it is that puts a ſtop to it, when the Animal is increaſed to the convenient and ordinary magnitude of the Species. This is either from a defect of the *ſuccus nutritius*, and becauſe the nature of the Ferments, which ſerve for Concoction, and Chylification, and the Craſis of the Blood at that time, when Accretion ceaſes, undergo ſuch an alteration, that the one does not produce, nor the other contain ſuch nutritive parts as are fit to be ſeparated by the nutritious Glandules: or elſe theſe Particles are ſtill ſupplied; but when they are ſeparated, and carried into the Interſtices of the fibrous, and bony Strings, or any other part, they have not leave to fix, and are not united to the part, which they are fit to give an increaſe to. That the firſt is not the Reaſon is evident. For although the Blood, and Ferments like other fermenting Liquors may undergo ſome alteration from time, though the Blood may be thought to amit much of its firſt ſweetneſs, and balſamick nature, and to grow ſharper, or more acrious with age, and tho we ſee it is ſo altered after ſome certain time as to contain, and ſupply a Liquor, which was not before to be ſeparated, or obſerved as that, which in Men ſerves for propagation, and we might reaſonably ſuppoſe that an alteration in the Blood on the other hand renders it uncapable of affording ſuch a *ſuccus*, as it had yielded before, that as Nature produces one, when it is neceſſary, ſo ſhe puts an end to the other, when it is not. I ſay notwithſtanding all this we cannot ſuppoſe ſuch an alteration and ſuch a defect to be the thing, which puts a ſtop to an Animal's growth, I mean naturally, and where the Animal is in a healthful State. For it plainly appears that there is a *ſuccus nutritius*, which is fit to be apponed, and to give an increaſe to the parts after the Animal ceaſes to grow, in that there is a reparation, and that not only of the fleſhy parts, but even of the Bones, when they have loſt ſome part of their ſubſtance, as *Diemerbroek* tells us of an adult perſon, who had a part of the *Tibia* ſawed off, that afterwards the Leg was extended to its former length, and after it was Set, was kept quiet, and ſtreight in a wooden Cradle, and by a *Callus*, which we cannot ſuppoſe to be any other than the *ſuccus nutritius* of the Bones, ſhooting from the ends of both thoſe pieces, where the Fracture was made, the loſs of that part, which had been taken off was repaired, and the broken pieces again united, and the ſame is more commonly ſeen in the Skull, when it has been trepan'd.

The reaſon therefore of this limitation I take to be becauſe the nutritious Particles, when they are ſeparated by the Glandules, and carried into the Interſtices of the fibrous Threads, of the bony Strings, and the other parts, are not ſuffered to lodge, and unite to the parts, which they were wont to nouriſh, and the reaſon of their diſturbance is, becauſe the Fibres are ſo tenſe, their proper parts ſo contiguous, and the extremities of the bony Particles ſo firmly united, that they will no longer recede, and make room to entertain them, where they may be out of the way of the Spirits direct motion. For although the nutritive parts, when they are driven by the Rotation of the Spirits againſt the Fibres, and the Strings of the Bones, can oblige them, ſo long as they are more lax, and tender, and their Particles more weakly and not univerſally united, to give way, and ſo thruſt themſelves into, and fix in a place, where they are out of the way of the Spirits direct motion, and although ſo long as the Spirits have a power either to force them laterally, or to remove the extremity of one from another, and to make an Interſtice between them, they will by their circular motion carry the nutritious Particles to one ſide, and fix them upon the filaments; yet when the Strings, or fibrils are ſo ſtreight, and their Particles ſo entirely united, that they can no longer give way to the preſſure made by the Spirits Rotation, or the nutritious Particles acted by them, ſo that there is now no poſſibility of obtaining any place, by which convenience the Spirits may make uſe, and have the benefit of their rotatory motion to carry the nutritious Particles to one ſide of that Line, in which they move, the *ſuccus nutritius* though it continues to be afterwards ſupplyed, cannot have the liberty to lodge, and unite as it did before. For ſtill the Spirits naturally endeavour to remove them, that they may neither ſtop their motion, nor alter their tendency, and now they begin to act upon, and to agitate them with their direct motion, which inſtead of driving them to, and fixing them upon the Fibres, and Strings of the ſolid parts, will carry them along in the ſmall paſſages or Interſtices, in which they move to the extremities of thoſe Interſtices, to the habit of the Body, and to ſeveral Glands, by ſome of which they are excerned, and continually ſpent. And though the incidence of one Body moving in a ſtreight line upon another may be ſuch, as will communicate a lateral motion to it; yet where there is no ſpace for the Body agitated to move laterally, or obliquely into, it will neceſſarily lie under the preſſure of that Body, which moves it, which preſſure will drive it along in that paſſage, wherein they are both moving. So the Spirits, though they have a rotatory motion; yet as they fill the ſmall Cavities in the fibrous parts, and the Channels, through which they move in the Bones, eſpecially when the Blood is in the beſt condition, and moſt capable of ſupplying a Nouriſhment, they can no longer faſten any of the nutritious Juice upon the ſides of the Interſtices, in which they flow, or ſuffer it to lodge quietly, and fix there, then the parts will recede, and allow ſo much ſpace as will receive the nutritious matter to one ſide of the line of their direct motion. As ſuppoſing a Ball exactly fitted to the Cavity of a Tube to be moving from one end towards the other, and that it likewiſe turns round its own Axis, ſuppoſing any matter, that is viſcous, lies in the way of its direct motion, ſo that the one impinges againſt the other, and the viſcous Body adheres to that, which is in motion, it is true the circular motion of the Ball wil carry it to the ſide of the Tube, but it cannot fix it there, ſo as to leave it behind, and proceed without it, becauſe no manner of incidence, no Rotation can carry the matter beyond the extenſion, and from under the power of the direct preſſure of the Ball, ſo that it muſt neceſſarily, when it has by its Rotation carried it to the ſide, drive it on by its direct motion to that extremity of the Tube, towards which it tends.

The account, which I have now given of the limitation of Accretion may not only ſatisfie us how there comes to be ſuch a diverſity in the ſize of Animals of a different kind, and the time, which they are allowed to grow in, but when dayly obſervation tells us, that all the Individuals of the ſame Species are not ſtrictly limited to the ſame degree of magnitude, ſome carry out their dimenſions farther than others,and ſome ceaſe to grow ſooner,than ſome, this Hypotheſis will ſerve to explicate the cauſe of the difference, and the reaſon of it is becauſe the Fibres are ſooner tenſe, and their proper Particles more contiguous to one another, and inſeparable to that power, which they have to reſiſt; becauſe the Particles, which conſtitute the bony Strings, are ſooner entirely united at their extremities in ſome, than in others, after which be it earlier, or later, the Spirits come to act upon the nutritious Particles by their direct motion, upon which the growth of the Animal neceſſarily ceaſes. Though for the different magnitude of ſome Individuals it muſt be granted that a more copious ſupply of the nutritious matter, and a greater plenty, and more vigorous activity of the Spirits to diſpoſe of it, and to make a greater preſſure upon the parts, whilſt they are capable of giving way both laterally, and at their extremities, are ſometimes the cauſe, why ſome are larger than others. And I do not queſtion but the Bones may contribute ſomthing in their increaſe to the elongation of the fibrous Threads, as their growth does inſenſibly ſtretch the Fibres, which are annexed to them.

As for the defect of Accretion, which is the Symptom of any Diſtemper in Children, or any perſons not adult, it ſeems commonly to be from the want of a *ſuccus nutritius*, and a deficience in the quantity, and vigour of the Spirits, beſides that their Appetite is languid, their Diet ſparing, and the motion of their Spirits too ſlow, and weak to attenuate the nutritive parts, the Ferments, which ſerve for Concoction,and Chylification, are ſo depraved, that either they do not extract, or they do not form ſuch Particles as are adapted to the figure of the Pores of the nutritious Glandules, according as the uſe, and deſign of theſe Ferments are either to work upon the nutritious Particles ſo as to give them a convènient figure, or only to diſpoſe them being already conveniently figurated, for a ſeparation.

And thus much ſhall ſerve for the buſineſs of Accretion, that, which comes next to be conſidered, is Nutrition, and this I take to be rather a ſupply of the fluid parts, and the maintenance of a plenitude in all the Pipes, and Veſſels of the Body, ſuch a continual reparation of Spirits, nutritious Particles, and of all the humours, in the Veſſels, Nerves, and Fibres, as keeps their Interſtices, and Cavities repleniſhed, and the parts themſelves in a due temperament, I ſay it is rather this, than the appoſition of new Matter to the ſolid parts. Tho I will not deny but ſome Particles, which were joyned to, and become a portion of a Fibre or any other ſolid part, may be ſometimes rubbed off, and ſeparated, from the tranſlation of which there will follow a vacancy, or void ſpace for entertaining ſome freſh nutritious Matter, and wherever it happens, ſo long as there are Spirits, they will by their Rotation immediately determine ſome new Particles to thoſe vacuities to ſupply the place of thoſe, which are removed. When the fibrous parts are eroded by Ulcers, and the Interſtices, in which the Spirits move, and to which the nutritious Particles are ſupplied, are ſet open ſo that the Spirits can by their rotatory motion act upon them, and carry them to one ſide of their direct motion, we find ſuch a ſupply of Nouriſhment, as repairs the loſs, and creates a new Fleſh. Or when a Bone is broken, it being impoſſible ſo exactly to ſet it, and to bring the two pieces ſo cloſe together, that there ſhall be no preternatural Interſtices, where the Fracture was made, there will be ſome little ſpaces found, which will be lateral to thoſe Interſtices, in which the Spirits move, and the nutritious Juice flows, and convenient for entertaining that part of the *ſuccus nutritius*, which the Arteries, that ſerve for their Nouriſhment, and the nutritious Glandules ſupply, and which the Rotation of the Spirits will determine to thoſe vacuities, where being lodged out of the way of the Spirits direct motion, and of that diſturbance, which their direct preſſure muſt give it, it quietly fixes there, and is united to the part, and this is that, which we call a *Callus*. I ſay there may be, and is all this, but we cannot reaſonably think that the ſubſtance of the ſolid parts is always in ſuch a flux, as ordinarily to ſecede, and to give way for the ſucceſſion, and appoſition of new Nouriſhment, no not ſo as to be once univerſally renewed in the whole interval between the Womb, and the Grave, nor that the imminution, which appears in the ſolid parts in an Atrophy, is from the loſs of their proper ſubſtance; but rather from a ſubſidence of the Veſſels, other drineſs of the Fibres or the exinanition of their Interſtices, and the emptineſs of the Cavous, and containing parts, all which for want of a plenitude to keep them diſtended, and their Cavities inlarged are contracted, ſo that the ſides of the Veſſels, and the Filaments, between which the Interſtices are formed, which before by a fulneſs of volatile, and fluid Matter were preſerved larger,and diſtended, come nearer to one another,or fall together,and the part,whereunto thoſe Veſſels, and Interſtices belong, muſt loſe ſo much of its breadth, and craſſitude as proceeded from their fulneſs and diſtenſion.

To make our ſelves ſenſible how the fleſhy parts are capable of ſuch a ſubſidence, as will detract from their thickneſs, and latitude even to a *Maraſmus*, we need only conſider how the whole Body is *vaſcular.* This the moſt ingenious Dr. *Tyſon* has in ſome Lectures of his publickly aſſerted, and beſides the Authority of ſo curious an Anatomiſt, thoſe that will be at the pains of making an enquiry may make a great ſtep towards their ſatisfaction in this matter by their own obſervation.For when any of the *Viſcera*, even thoſe, which ſeem moſt compact, and free from Pores and Cavities, are ſtrictly examined, that, which was formerly taken to be only a *Parenchyma*, or Maſs of congealed Matter, appears to be nothing but Veſſels for the Motion, and Conveyance, and Veſicles, or cavous Glandules for the ſeparation, with Cavities in ſome for the reception of ſome fluid Matter, which the indefatigable, and ſagacious *Malpighi* has diſcovered, and ſufficiently convinced us of. And wherever our Senſes leave us wholly to the conduct of our Reaſon, we may rationally think that the ſtructure of the parts is Vaſcular. For how certain is it that the Arteries are continued where we cannot diſcover their Cavities ? Who queſtions but that the Nerves have their *Canaliculi* ? They that maintain the motion of the Spirits, or a *ſuccus nervoſus* through them do implicitly grant it. And if they have their ſmall Pipes, whilſt they are Nerves, there is no reaſon to think their *Caniculi* terminate when their Fibres are expanded in a Muſcle, ſeeing the Fibres themſelves are continued. The whole Body therefore being Vaſcular we need not ſuppoſe any thing more than a ſubſidence of the Veſſels to explain the immediate cauſe of that imminution of the fibrous parts, which is ſeen in an Atrophy. The Veins, and Arteries not being diſtended as they ought to be, the nervous, and fibrous Channels not being repleniſhed, the veſiculous parts, ſuch as the Fat is contained in, being empty, and contracted, the conſequence of all this muſt neceſſarily be a remarkable alteration in ſome dimenſions of the part, which they conſtitute.

The nature of the humours, and Spirits, it is plain enough, is ſuch that they may be eaſily evaporated, or ſome other way excerned out of the Body. What quantities of them are ſometimes loſt by Sweats, and other ways of evacuation. And in Ulcers, where the *fibrillæ* are eroded, and the Pipes, in which the Spirits move, and to which the *ſuccus nutritius* is ſupplyed by the nutritious Glandules, are ſet open, ſo that both may extravaſate, what an expence of the nutritious parts, and conſequently what a notorious defect may we obſerve in Nutrition, when the Ulcers are large; ſo that we have often an Atrophy not only of that particulart part, where the Ulcer is, but even of the whole Body. Beſides, the nature of the Fat, and oily parts, which make a conſiderable addition to the extenſion of the parts, to which they are ſupplied, not only is ſuch that they are capable of being put into a flux or made fluid, but they are actually liquid, whilſt the natural heat of the Body remains, ſo that they are eaſily divided from one another, and ſeparable from the parts, which they lie contiguous to, and ſo excernible out of the Body. And unleſs there be a freſh ſupply to repair the loſs, of that, which is evacuated, and did before fill their ſmall bags, theſe *Veſiculæ* will contract themſelves, or ſubſide, which is natural to parts of their Texture, and Fabrick, when they are empty, and their ſubſidence will detract ſo much from any dimenſion, as the Matter, which before diſtended them, added to it.

But the ſubſtance of the ſolid parts is ſuch, that it can neither be exhaled, nor melted down by any heat of the Body, ſo that if they do indeed ſuffer an imminution in their proper ſubſtance, it muſt be by the way of an eroſion, and be the injurious effect of ſuch a corroſive Matter, as will diſſolve them, and eat off the Particles, the conſequence of which would be Ulcers in all thoſe parts, which are thus imminiſhed, and ſuch a Corroſive could not ſo affect the Fibres without the conjunction of an intolerable pain, and the torments of the Stone, and Gout would be moderate and eaſie to them, which in a Conſumption would be univerſal, whereas in a *Tabes* we have no ſuch Symptom. To which may be added another Argument, which ſeems to prove againſt all contradiction, that the imminution is not in the ſolid parts, which is from what we cannot but obſerve in the Bones in the greateſt Conſumptions, that whilſt other parts are ſinking, and tabid, they are not found to loſe any thing of their magnitude. And why ſo?

Were there a corroſive humour, that eats away the very ſubſtance of the Fleſh, where it is affected with an Atrophy, it would prey as certainly, and more voraciouſly upon the Bones. For upon trial it appears that a Corroſive, as *Aqua fortis*, will ſooner perfectly diſſolve a piece of a Bone, than the ſame quantity, or weight of the muſcular Fibres. The reaſon therefore is becauſe the Strings of the Bones are more rigid, ſo that though the Bones may be equal ſufferers with the Fibres, that is their Spirits, and nutritious Juice may be ſubtracted in a Conſumption, as they are in other parts; yet ſtill they keep the ſame poſture, that they were in before, and being uncapable of a ſubſidence, they are not attended with the ſame ſymptom of an evident imminution.

The loſs therefore of what is expended being in the Spirituous, the Humoroſe, and Fluid parts, and Nutrition being only the reparation of thoſe parts, which Nature continually ſuffers the expence of, it follows that it is no ſuch thing ordinarily as the repairing of dilapidations, or the filling up of breaches in the ſolid or containing parts, but only a ſupply of ſuch Matter as continues in a Flux, which keeps them full, and manitains the natural circumference of every part.

There is one thing, which I promiſed to do under this Head, and it is to anſwer that objection, which is levelled againſt the Opinion that the nutritious Particles are derived from the Maſs of Blood, and is urged as an Argument to prove they are ſupplied from the Nerves, which is taken from the obſervation of an Atrophy in ſome Palſies. The ſtrength of this objection is wholly depending upon a falſe Notion about Nutrition, to wit, that the ſubſtance of the ſolid parts is in ſome meaſure daily expended, and loſt, and that the *ſuccus nutritius* is apponed, and united to the parts in the whole courſe of a Man's life, as in the time of Accretion, otherways it has not the ſtrength either of an Objection one way, or of an Argument the other. For if Nutrition be only maintaining the fulneſs of the Veſſels, which contain the ſeveral humours, and oily parts, and that of the Cavities of the Fibres, and an Atrophy be only a ſubſidence of all, or ſome of theſe, the ſubſidence, if it were only of the Nerves and muſcular Fibres ſhews only a defect of ſomething to fill their Cavities, and does not prove it to be the want particularly of a nutritious Juice, when it may be a deficience of Spirits only. But we may ſafely grant the very Notion, upon which the Objection is grounded, to be true, that nutrition is, what they would ſuppoſe a reparation of the ſolid parts, without the leaſt prejudice to that Opinion that the nutritive parts are ſupplied from the Maſs of Blood, though they do not anſwer the end, which they are deſigned for, in a Palſie. For although the Maſs of Blood, in which we ſuppoſe the nutritive parts reſide, continues to Circulate through any part, that is Paralytick; yet the want of Spirits will have this effect to hinder the ſeparation of the nouriſhment, when the evil ſpreads it ſelf ſo far as to affect the Fibres of the nutritious Glandules. For without the Spirits the Fibres of theſe parts loſe their tone, and can never be kept tenſe, nor the natural figure of the glandular Pores be preſerved, which being altered by the relaxation of the Fibres of the Glandules become uncapable of ſeparating thoſe Particles, which are adapted to the natural, but diſagreeing from the preſent figure of their Pores. And by that account which I have given of Nutrition, it will be no difficult thing to explain the reaſon of an evident abatement in the natural magnitude of any part, when it is the conſequence of a Palſie. For the Fibres being obſtructed, and the influx of the Spirits, which ought to fill, and inflate them, and the ſupply of their *ſuccus nutritius*, which as I have already ſhewn is naturally ſupplied though not apponed to the ſolid parts after Accretion ceaſes, being hindered, there will neceſſarily follow the loſs of ſo much of the magnitude of any parts as proceeded from that meaſure of Spirits, and their proper nutritious Juice, which is now denied to them. And beſides the ſubſidence in the nervous Pipes, there is alſo a contraction, or falling of the Blood Veſſels. For the expanſion of the Particles of the Blood, and the turgeſcence of thoſe Veſſels in every part depending much upon the motion, and energy of the Spirits flowing into it, it cannot be thought, though the Blood continues its influx into any paralytick part, that the ſanguiferous Veſſels will be ſo much dilated, when the obſtruction, and defect of the Spirits are ſo great that they ceaſe to flow into, and give an activity to the Blood that circulates through them, as when it was rarified, and expanded. And this difference we may find eſpecially in perſons, that are lean, from Heat, and Cold, that when the Hands are very warm, the Veſſels are more turgid, and the parts are plumper, and more large, but when the cold weakens the activity of the volatile Particles, and reſiſts the expanſion of thoſe, which are agitated by them, the parts ſeem as if they had ſome degree of a ſudden Atrophy, and the Skin becomes flaccid.

What I have ſaid of Accretion in general might be ſufficient to explain the manner, how the Bones do increaſe, and how a *Callus* is ſupplied to a broken Bone; but becauſe I entered upon the conſideration of Accretion upon the account of theſe parts, I cannot but ſay ſomething particularly of the manner of their encreaſe. That they have many Arteries beſtowed even upon their moſt ſolid part, and deſigned for their Nouriſhment I have already obſerved, and given ſome deſcription of them. By theſe Veſſels is conveyed into them the Maſs of Blood, from which the Particles, that nouriſh them, are ſeparated by Glandules ſeated in the ſides of the arterial Channels, which being carried into the Interſtices of the Strings of the Bones, in which their Spirits move, will lie in the way of the Spirits motion, and thereupon are in the manner, which I have already explained, by their Rotation, or circular motion carried to the ſides of the Strings, ſo as to make a preſſure upon their Particles, by this preſſure made upon the ſides of them, ſo long as the extremities of the bony Particles are not united, they force them to recede laterally, and inſinuating themſelves between their extremities inlarge the diſtance between them, and oblige them to give way, and ſo they obtain a ſpace, which entertains them out of the way of the Spirits direct motion, and where they are contiguous to the bony Particles, to which they adhere, and unite.

Neither are we at a loſs for Spirits in the Bones to act their part in this buſineſs, ſince they receive a continual and plentiful ſupply of them from the *Perioſteum*, by the Fibres of which they flow into the Interſtices of their Strings, and move in them as their Channels, as they did in thoſe of the Fibres in the Nerves, and all the fibrous parts.

That we may the better underſtand how the Particles of the Bones are capable of receding both laterally, and at their extremities, we muſt conſider that the Bones of a *Fœtus* are ſoft, and their parts at one time eaſily diviſible, ſo that they will ſenſibly yield to the preſſure of the Finger, when an Infant is Born they have very much of a cartilaginous Nature, and it is a conſiderable time before they arrive at the perfect ſolidity of a Bone, Now a Cartilage, as I ſhall farther ſhew, when I come to diſcourſe of thoſe parts, is nothing but an imperfect Bone, or a Bone, in which the extremities of the Particles are not united to form continued Threads, but there are ſmall Interſtices between them, though they are ſo diſpoſed as to preſerve the continuity of the whole Cartilage, and although when it advances nearer to the true, and perfect Nature of a Bone many of them are united ; yet they are not all ſo until the Bone obtains its due ſolidity. So that whilſt the Bones are cartilaginous, or bordering upon the nature of a Cartilage, their Particles are capable of receding both to one ſide, and at their extremities, which being moved by the preſſure of the nutritious Juice driven againſt them by the Rotation of the Spirits, they make room for lodging of the Nouriſhment out of the way of the Spirits direct motion; Thoſe Particles, which are driven againſt, and apponed to the ſides of the ſeveral parts of the bony Strings increaſe the thickneſs, and enlarge the circumference of a Bone, thoſe which are forced in between their extremities, widen the Interſtices, and ſticking there, elongate every ſeries of the bony Particles, and conſequently the whole Bone.

But when theſe Particles come to be united at their extremities, that will be the boundary of their recedure, and limit the growth of a Bone. Though I ſuppoſe likewiſe a lateral union, yet the firſt only will neceſſarily prevent the farther increaſe of their craſſitude as well as of their length, where the Strings are continued in the manner of a Ring, as they are in all the Bones. For unleſs the Spirits have a power of breaking this continuity they can neither protrude, nor elongate theſe Strings either on one ſide, or the other, after their Particles are firmly united. And as they cannot protrude the parts of a String, ſo neither can they fix any part of the nutritious Juice upon them, becauſe ſo long as it is in the Interſtices it muſt be diſturbed and propelled by their direct motion, which may probably drive it on till it comes into ſome way, which leads it to an evacuation. I do think too that the *Perioſteum*, which I have already diſcourſed of, does, as I then ſuppoſed, help to preſcribe limits to the increaſe of theſe ſolid parts, when its growth, and extenſion ceaſe. But ſuppoſe that none of the bony Strings were ſo united as to become annular, I mean to be continued in the manner, though not in the figure of a Ring, nor any oppoſition made to their recedure by the *Perioſteum*; yet the Bones, and the parts, which they conſiſt of, being of a fixed, and quiet nature contrary to that of the Spirits, and all active Particles, ſo long indeed as the preſſure of the *ſuccus nutritius* from the Rotatory motion of the Spirits is ſo ſtrong and violent as to exceed, and overpower the quietude, and fixity in thoſe parts, it will oblige them to recede, but when they come to an *æquilibrium*, that the degree of quieſcence in theſe ſolid parts anſwers exactly the power of the Spirits motion, much more if it exceeds it, the fixed Particles of the Bones will begin to ſtand their ground, and none can without abſurdity ſuppoſe they ſhould be moved, and protruded by that force, which they are able to reſiſt.

What I have ſaid of Nutrition in general, I may confidently affirm of that of the Bones, that it is not ordinarily a reparation of their ſubſtance or ſolid part, or the ſucceſſion of new Particles to any that are deſtroyed, and expended after they are aſſimilated. For the Particles of theſe ſolid parts are ſo fixed, and firmly united after the time of their Accretion, that their Nature will not give us leave to think they are capable of ſuch a flux as is neceſſary to ſuch a change, and ſucceſſion of Matter. So that their Nutrition is no more than a conſtant ſupply of Blood to their ſanguiferous Veſſels, of Spirits to the Interſtices of their Strings, and of their nutritious Juice, which when a Bone is broken, or deprived of part of any of its *Laminæ*, though it be after the time of Accretion, is upon theſe occaſions employed, and apponed in the ſame manner as it was, when it gave an increaſe to theſe parts; it is carried by the Rotation of the Spirits to thoſe Interſtices, and defective parts, where a *Callus* or bony ſubſtance is neceſſary to knit the pieces, which are fractured, or to ſupply what is loſt by Trepaning, or Exfoliation.

From that Hypotheſis, by which I have endeavoured to explain the manner of the Bones Accretion, we may, as I humbly conceive, be able rationally to account for the Symptoms, which we obſerve in theſe parts in the Rickets, and for the *Gummata*, which often appear in the *French* Diſeaſe.

The Symptoms, which attend ſome of the Bones in the Rickets, are an Incurvation, a knottineſs, and protuberance at their ends. The ingenious Dr. *Mayo* has endeavoured to give us the reaſons of the obliquity of ſome of the Bones in this Diſtemper, by ſuppoſing a diſproportionate growth in the Bones, and the Muſcles, which are affixed to them, that the nervous, and muſcular parts for want of a ſufficient quantity of a *ſuccus nervoſus*, which he conceives to be neceſſary to their Accretion, have not that addition made to their dimenſions in this caſe, which they ought to have, whereby they fall ſhort of that length, which ſhould give them a proportion to the reſt of the parts, and which a natural Accretion would have procured; but all this while he would have the Bones to be nouriſhed, and to increaſe no leſs in Rickety, than in Healthful and thriving Children. But as it does not appear that there is any ſuch reaſon for this affection of the Bones; ſo if we ſhould ſuppoſe the inequality, which is in the diſtribution of the nouriſhment in this caſe, to be between the Bones, and the Muſcles, and not between ſeveral parts of the ſame Bone; yet it would do us but little ſervice in explaining the reaſon of the Bones obliquity, neither would their Incurvation follow upon what he ſuppoſes. The ingenious Author's Notion is this, that the Muſcles, as I have ſaid, from a defect of a nervous Juice neceſſary to their Nutrition are not nouriſhed, and extended as they ought to be, but the Bones, from whence they have their origination, and which their Tendons are inſerted into, inlarge their dimenſions: Now the origination, and termination of the Muſcles hindering thoſe bony parts, which lie within theſe bounds, from extending their length in a right Line, that growth, and addition, which make them exceed the length of their Muſcles, will alter their figure and incline them to that of a Bow, as it is certain if any Line be elongated, whilſt the extremities are fixed within the ſame bounds, it will neceſſarily of a ſtreight Line become oblique. This indeed might ſolve the *Phænomenon*, if the origination of a Muſcle were from, and the inſertion of it into the ſame Bone. But this is evident, that as the Muſcles are deſigned for Motion, ſo between their beginning and the inſertion of their Tendon Nature has to make the part moveable formed an Articulation, ſo that the brevity, and ſtreightneſs of the Muſcles would bend the Joynt, and not produce an obliquity in the two Bones, which are articulated, or in any one of them. So long as there is an Articulation, between thoſe two extreme parts, which he would ſuppoſe to be fixed by the beginning, and Tendon of a Muſcle, and that part, where the inſertion is, being not only capable, but apt to be attracted towards the other, where the origination is, upon the preternatural ſhortneſs of the Muſcles, juſt as it is in muſcular Motion, where there is a contraction of the muſcular Fibres, and their length is not equal to the diſtance, which is between their beginning, and inſertion, when the Bone, which they move is extended, there will follow an alteration in their poſture, but no one of them will be obliged to alter its figure. Are not the Muſcles, when they move any part, ſo ſhortned as to put a ſtreſs upon the Bones, and to bring that part of a Bone, which they are inſerted into, towards their origination; and what do we find is the effect of this abbreviation, have we an obliquity following in the Bones themſelves? No ſuch thing, but only a flexure at the Joynt. The example he gives us of a young and thrifty Tree, that has whilſt it is growing the ends of a Chord fixed to it, the one in the ſuperior part, and the other below, ſo that the String is extended to its full length, but the Tree at firſt not at all inclined, is not Parallel. There is no doubt of this, and it is demonſtrable, that the Tree, which receives its Nouriſhment,

ment, and is extended in its length, when it cannot carry either of thoſe extreme parts, to which the Chord, that is not equally elongated, is fixed, beyond thoſe limits, which were ſet before it had this increaſe, that is, it is uncapable of an elongation in a direct Line, what ever is added to the length of it muſt be out of a ſtreight Line, and give the Tree the obliquity, and figure of a Bow. But we muſt conſider, that this is one Stick, one continued Body, which has no Articulation, which if we ſuppoſed it to have, the flexure would be only at that Joynt, and ſo all the other parts between the Ligatures would preſerve their rectitude, and firſt figure.

Dr. *Gliſſon's* Hypotheſis, methinks, ſeems to be more rational, that the inequality and diſproportion of Nouriſhment lies between ſeveral parts of the Bone, which is thus affected, that the nutritious Particles are plentifully ſupplied on one ſide, whilſt on the oppoſite ſide the Bone wants its due Nouriſhment, the neceſſary conſequence of which will be an Incurvation, and the Bone will be reduced to the figure of a Bow, whoſe Convex will be on that part which is duly nouriſhed, and the Concave on that ſide, where the nutritious Juice is not proportionably apponed. This he proves will be the effect of an unequal Nouriſhment in the Bone it ſelf; by an inſtance he gives, 'Let there be a Pillar, ſays he, 'raiſed with three Stones, lying one upon another, let us ſuppoſe it to be ſuch as is perpendicularly ſtreight on every ſide, and of the 'ſame height, if therefore we put in a wedge 'on the right ſide between the uppermoſt and 'the middle Stones, the higheſt Stone will be 'inclined towards the left hand, and the Pillar 'will be raiſed higher on that ſide where the 'Wedge is driven in, than it is on the oppoſite 'part, likewiſe if we drive in a Wedge between 'the middle Stone and that, which is the Baſis 'on the ſame ſide, the Pillar will yet be more 'inclined, and ſtand bending towards the left 'hand, and the more Stones it conſiſts of, if a 'Wedge be put in between every two of them 'on the ſame ſide, ſo much the greater will the 'obliquity be in the whole, ſo that the Stones 'will no longer make an erect Pillar, but repreſent part of an Arch, as he has expreſt it by a Figure. It is true every Stone that is thus raiſed will with that, which it immediately reſts upon, make an Angle on that part towards which it inclines, whereas there are no ſuch Angles in theſe incurvated Bones. But the reaſon of the difference will appear, if we conſider what he farther ſays, that the Nutrition, which on one ſide is moſt conſiderable, is there in a manner equally performed in all the length of it, and from this equal Nutrition, the

Incurvation of the Bone will make exactly a part of a Circle without any Angles.

We will ſee how this notion may be farther explained by that account, which I have given of the manner of the Bones Accretion. Much of the difference between a Bone, and a Cartilage I then obſerved to conſiſt in this, that in one, to wit, the Bone, the Particles are at their extremities, which lie oppoſite to one another in every ſeries, united in the whole length of it, ſo as to form continued Strings, whereas in the other the Particles are ſo far from this; that there are minute Interſtices between their extremities. Whilſt therefore the Bones border upon the Nature and Conſtitution of a Cartilage, as they do in young Children, the extremities of their Particles are capable of being removed, and ſet at a greater diſtance from one another, and will admit between them the nutritious Particles like ſo many Wedges driven in between the the Stones of a Pillar, and where the ſupply of the nutritious Juice is moſt plentiful, and the quantity of the Spirits, which forces the nouriſhing Particles into them, is greateſt, and their preſſure ſtrongeſt, there the Particles of the Bone will be obliged to recede fartheſt, the conſequence of which will be a more conſiderable elongation of every ſeries on that ſide, when on the other, if there be any defect of the nutritious Juice, and the activity of the Spirits be more languid, the extremities of the bony Particles will not recede to the ſame degree, nor the Accretion of that part proceed with an equal pace, and thus one ſide comes to be ſhorter than the other, and that part, which is moſt extended in its length, will incline the Bone towards the contrary ſide, and reduce it to the figure of a Bow.

But although this account does fairly explain the reaſon of the Incurvation of the Bones in the Rickets, yet I do not think that the diſproportionate quantity of the Nouriſhment, which is ſupplied, and the unequal influence of the Spirits are the true cauſes, why one part of a Bone is nouriſhed more than another, but I take it to be rather from ſome difference in the nature of ſeveral parts of a Bone, in one it puts off the form and temper of a Cartilage more, and ſooner, than it does in another, and if the Particles happen to be united, and to form continued Strings, that they are not ſo capable of receding, and ready to make room for the entertaining of the nutritious Particles out of the way of the Spirits direct motion, ſooner on one ſide than on the other, that is, the part is there more haſty in its tendency towards the perfect nature and ſolidity of a Bone, ſo that the Spirits, and nutritious Juice, though their quantity, and preſſure be equal on every ſide, cannot oblige the Particles equally to recede, then will the Accretion of the Bone ceaſe on one ſide, or proceed ſlowly if ſome of the Particles remain diſunited at their extremities, whilſt it is carried on more effectually, and evidently on the other, which may be more fully explained and underſtood by what I have ſaid of the reaſon, why Accretion ceaſes in grown Animals. I muſt confeſs I never had an opportunity to examine the Bones of any rickety Children, however I am ſtrongly perſuaded if an enquiry be made into them, which are incurvated, the Concave part will be found to be more ſolid, and like the perfect Bone of an adult perſon, and the nature of the Convex, more agreeable to the age of the Child to whom it did belong. And this we may conclude from the nature of thoſe Oils, which we make uſe of externally to the part affected in this diſtemper, which are emollient, and relaxing, ſuch as are apt to looſen the extremities of the Particles, to diſſolve that union, that continuity of them, which makes the Strings more firm and rigid, at leaſt to weaken it ſo, that the power of the Spirits, and the preſſure of the nutritious Juice acted by them, may be able to diſſolve it, and make the Particles capable of receding at their extremities, which is neceſſary in the elongation of a Bone. And ſo the reaſon is obvious why theſe external remedies are to be applied to the Concave part of the Bone, when it is incurvated, which is where the extremities of the Particles are united, and not diſpoſed to recede, and to receive any part of the nutritious Juice out of the way of the Spirits direct motion, which every good Woman, that pretends to cure the Rickets, obſerves to do.

From this ſuppoſition that the Interſtices between the extremities of the bony particles, and the liberty, they have to recede upon the preſſure of the *ſuccus nutritius* are that, which makes the Bones capable of an increaſe, we may account for the preternatural increaſe, and knottineſs of the ends of ſome Bones. For in Children at firſt the extremities of the articulated Bones are but tender Cartilages, and ſome of them, as thoſe of the Wriſt, wholly Cartilaginous, and not only ſo, but that medullary Oil, and mucilage, which are ſupplied to, which lubricate and moiſten thoſe parts, that are found to be thus nodous, keep their Particles lax, and prevent their natural tendency to a union, as we ſee this mixture even in grown perſons has ſo far the ſame effect upon theſe parts, that they never obtain ſo great a ſolidity, as is in thoſe parts of the articulated Bones, which are never moiſtened with the mucilage. In young Children therefore, where theſe parts of the Bones ate naturally ſoft, and the extremities of the Particles are kept more lax, and longer diſunited by a moiſt, and mucilaginous Matter, than the other parts of them, there is ſometimes, as in theſe rickety caſes, a preternatural laxneſs, and a greater indiſpoſition in the Particles to unite, and conſequently a weaker oppoſition to the preſſure of the nutritious Juice, whereupon they are protruded in an extraordinary manner, and give way for the entertainment of a greater quantity of the *ſuccus nutritius*, than what is neceſſary for their regular, and natural increaſe.

For the *Gummata* or Nodes, which appear upon the Bones in the *Lues Venerea*, ſince by a long continuance, and their induration they take upon them the nature of a bony ſubſtance, it is not to be doubted, but that they are produced from the *ſuccus nutritius* of the Bones, as their material cauſe, which is extravaſated, and caſt out upon their ſuperficies, where it adheres, and produces a preternatural excreſcence. The nutritious Juice, after it is ſeparated from the Maſs of Blood, comes to flow in the Interſtices of the bony Strings. So long as theſe Channels are entire, and have no breach in all their courſe, the nutritious

Particles are as it were kept within their Banks, but when the continuity of the Strings is broken by the leaſt preternatural foramen, then the nutritious Juice finds a paſſage to flow out at, and when any parts of it come to be oppoſite to it, the Rotation of the Spirits will carry them into it, and by the ſucceſſion, and preſſure of one Particle upon another they are driven out of the Bone, where lying out from the Line of the Spirits direct motion, their viſcous nature diſpoſes them to adhere, and they generate a ſubſtance like that of the part, which they are fit to nouriſh. So we find when the Fibres loſe their continuity, and the ſmall Channels, in which the Spirits move, and where their nutritious Juice flows, have any preternatural avenues, whether it be by the Knife, as in Iſſues, that are cut, or by the Corroſion of ſome ſharp, and ulcerous Matter, that the nutritious parts contained in them are thrown into thoſe *foramina*, and Cavities, to repair the loſs of what is deſtroyed, and to reſtore the natural continuity of the Strings, which are corroded, and even where the caſe is ſo ill, that there is no diſpoſition to heal, yet often we are ſenſible of the extravaſation of the *ſuccus nutritius* from the fungous Fleſh, that ariſes. Now the venenoſe Particles, which affect the Blood in the *French* Diſeaſe, are both ſubtle, and acrious,

ous, which, when they are ſcattered through the whole ſanguineous Maſs, will be apt to attend any humour, that is ſeparated from it, being by reaſon of their ſubtility capable of entring the Glandules of any part. For although the Pores of diverſe Glandules are differently figurated, yet this will not neceſſitate theſe Particles to be ſeparated by thoſe of one ſort, becauſe they are ſo minute, and ſubtile as to penetrate thoſe Pores, which are of a different figure. And thus ſubtle we find the malignant Particles in the *Lues Venerea* to be, when they are diſcharged by ſeveral Glands, ſometimes they inſinuate themſelves into the Salivatory, the Urinary, the Pulmonary, the nutritious Glandules of the Fibrous parts, and raiſe ſeveral Symptoms, where they are ſeparated and depoſited. And as the nervous Threads are ſometimes corroded, and the nutritious Juice extravaſated out of their Interſtices produces Caruncles in the fibrous parts, ſo the ſame morbifick Particles, when they penetrate the Pores of the nutritious Glandules in the Bones, are mingled, and confounded with the Nouriſhment in the Interſtices, where by the means of their ſubtility being arrived, by their acrimony they corrode ſome of the Strings, ſo as to eat ſmall paſſages in the ſides of their Interſtices, which when they reach the ſuperficies,

perficies, are a way for the efflux of the nouriſhing parts, which by the power of the Spirits rotatory motion are carried into them, and by the preſſure of ſuch as ſucceed them are driven to the ſuperficies, where they concrete, and produce an excreſcence, which repreſents the nature of the part, which they are proper for the Nouriſhment of.

The THIRD DISCOURSE OF THE MARROW.

THE Cavities, which Nature has formed within the Bones, are neither empty, and uſeleſs vacancies, nor filled with Lumber, and contemptible matter, but convenient Repoſitories for a curious, and refined ſubſtance neceſſary for the ſervice of thoſe parts, that contain it, which is called the Marrow. The nature of the Matter, which is here ſeparated, and depoſited, and immediately ſerviceable to the Bones, is wholly oleaginous. However the whole Maſs, or Body of the *Medulla* conſiſts of ſeveral parts, to wit, of Blood Veſſels both Veins and Arteries, of Glandules, and containing parts, and the oily Matter, which is contained in them.

It has Blood-Veſſels, proper to it ſelf. The Artery is ſometimes ſingle, ſometimes there are two, or three, and in ſome Bones as particularly in ſome of the Ribs, they exceed that number, having every one of them a diſtinct *Foramen* formed in the ſide of the Bone for their paſſage into the Cavities. It paſſes through theſe *Foramina* without any diviſion, or ramification, for I could never obſerve that any of them ſent forth any Twigs into the ſubſtance of the Bone for its Nouriſhment, but were deſigned ſolely for the Marrow. After it comes into the large Cavity, or into the leſſer Caverns, when the Bones are ſpongious, it is commonly divided into two, one aſcending towards one extremity, and the other deſcending towards the other, both of which in their whole tendency are ſo ramified as to give a Twig to every Veſicle, that performs the office of a Glandule. Though I have with a Glaſs diſcerned ſeveral minute Blood-Veſſels belonging to a ſingle Bag; yet I cannot ſay I have been able to obſerve, that every Veſicle has a Blood-Veſſel, neither do I think it has. For there being a communication between the Veſicles by Pores, as I ſhall afterwards ſhew, there may be a ſupply of the medullary Oil to fill thoſe, which have not Blood-Veſſels of their own in order to ſupply ſuch oily parts, and do not ſeparate them themſelves.

As for the Veins, they run from the termination of the Arteries, ſome all along within the Marrow to the *Foramen*, through which the Artery enters, and fall into one large Channel, which paſſes through the ſame *Foramen*, others tend to the ſuperficies of the Marrow, whereof ſome, which are minute, I have obſerved to paſs immediately through the Membrane, and to penetrate into the ſide of the Bone, which we muſt ſuppoſe to diſcharge themſelves either into ſome Vein of the *Perioſteum*, if they proceed ſo far, or into ſome of them, which are in the ſubſtance of the Bone, and belong to the nutritious Arteries; others run upon the ſuperficies of the Marrow, between that, and the Membrane, which fall at laſt into that larger Veſſel, which paſſes out by the *Foramen* of the Artery. Where there are two, or more conſpicuous paſſages it is probable that ſometimes the Vein may paſs ſingly through one, and the Artery through the other, though I have not yet obſerved it to be ſo.

The Secretory Organs are ſmall veſiculous Glandules, which I take to be likewiſe containing parts, and continually kept full by the Oil, which they themſelves ſeparate, which before I give an account of, I ſhall take notice of a common containing part inveſting the whole *Medulla*. The oily therefore, the veſiculous, and vaſcular parts of the Marrow are all contained in one common, moſt thin, and tender Membrane, tranſparent as Glaſs, which inveſts that part, which lies in the bony Cells, as well as that, which fills the larger Cavities. The origine of this Membrane is certainly from the Blood-Veſſels. For here we have nothing elſe, no other Membrane, no Nerves, no tendinous, or muſcular Fibres, from whence we can ſuppoſe it to be derived. Neither do I think it is from all the Blood-Veſſels, but only from the Arteries, nor from all the Coats of an Artery, but from the exterior only, that it is an expanſion, and an elongation of the Fibres of this Coat. It is ſo thin, that it does not ſeem to be made of the Fibres of more, neither have I been able to obſerve that it is diviſible like the ſeveral Coats of an Artery, or that it has the leaſt reſemblance to any other, than that I mentioned, but it is plainly a *Reticulum*, or fine Net like the Texture of that. It ſeems in many places to be red, as if it had a great number of Blood-Veſſels, but this is not occaſioned by Veſſels, or Blood of its own, but ſome of the medullary Veins running upon the ſuperficies of the Marrow, which lies under it, by reaſon of its tranſparency make it ſeem to retain that colour, which it only tranſmits. I do confeſs I have not been always able, when I have endeavoured it, to ſeparate the Membrane from the Veſſels, which communicated that colour to it. For eſpecially where the Marrow is ſoft, they will riſe with the Membrane, when it is ſeparated from the *Medulla,* and it is no wonder when it is propagated from ſome of the Blood-Veſſels, ſo that there is a connexion, and the implication of theſe with others, will make them riſe together; and it is ſo tender, that it is almoſt impoſſible to divide them afterwards. But I have ſo often ſeparated them in that part of the Marrow, which has been more indurated, and afterwards viewed the Veſſels upon the ſuperficies of the Marrow, as to be certain that they are not a part of the Membrane, but only ſubjacent, and ſo give it their own colour, as any Opace Body will do to that, which is diaphanous, when it lies behind it.

This Membrane adheres to the Bone, not only by thoſe ſmall Veins, which are continued from one into the other, but likewiſe by inſinuating it ſelf into the tranſverſe Pores of the firſt internal *Lamell,* and that as I ſuppoſe, for the better paſſage of the medullary Oil through one into the other. This is certain, that it has Pores, by which the Oil flows through it into the Bone it ſelf, which it is reaſonable to think are formed in thoſe parts of the Membrane, which lie into the Pores of the firſt Plate, by which one does more conveniently, and certainly receive it from the other. Neither can it ſeem ſtrange that the Oil ſhould have its egreſs, after it is ſeparated by the Glands, through Pores formed in this Membrane, when we conſider that it is not an unparallelled caſe, but the Sweat after it is ſeparated by the cutaneous Glands paſſes through the *Cuticula* by ſuch Pores. By the elevation, or protruſion of this Membrane in ſeveral places to inſinuate it ſelf ſome little way into the tranſverſe Pores on the inſide of the Bone are formed little round protuberances, which render the ſurface of the Marrow unequal.

The medullary Oil, which is contained in this Membrane, does not lie all confuſed, and indiſtinguiſhed in that ſpace, which the common Membrane circumſcribes, but there are Diviſions, and Subdiviſions, in the Membrane are immediately contained membranaceous Bags, and in theſe Bags are *Veſiculæ* or little Bladders: both which I have obſerved where the Marrow has been ſoft, and the Oil continued liquid after it was cold. And when I came to enquire into that part of the *Medulla*, which was indurated, I found by examining of it when it was made hot, and liquid, that the ſtructure of the containing parts was exactly the ſame, only I could not diſtinguiſh the tender Bags ſo well.

The Bags, or Lobules made up of ſeveral *Veſiculæ* are not all of the ſame Figure, nor of the ſame capacity, even in a large Maſs of Marrow, and for thoſe which fill the ſmall Cavities, it is plain they are variouſly figurated, and different in their extenſion, as the Cavities themſelves are ſo, and in ſome of the ſimple Caverns, which are very ſmall, that which fills them hardly deſerves the name of a Bag, for in ſome there cannot be more than two or three *Veſiculæ*, and in ſome I cannot tell how to think there is more than a ſingle Veſicle.

The *Veſiculæ* are ſmall glandular Bladders deſigned for the ſeparation of the medullary Oil from the Maſs of Blood, and for the reception of it. Theſe are as far as I can obſerve all of the ſame figure, being round, neither do they differ in their capacity. In that part of the Marrow where the Oil is fluid, and clear they are to look to, very much like the veſiculous ſubſtance of the Lungs, when they are blown up, but that the *Veſiculæ* are not ſo large. In a ſmall piece of the *Medulla*, where the Oil is indurated, they repreſent, when they are viewed with a magnifying Glaſs, a cluſter of ſmall Pearl ſticking one to another. In a humane Bone, which I had preſerved till the Oil was wholly evaporated, I found theſe *Veſiculæ* remaining dry but entire, and their ſubſtance repreſenting in a manner a Sponge. The medullary Oil being contained in ſeveral ſmall Veſicles, from hence it comes to paſs that if any one of the Bags be opened, it does not preſently empty it ſelf, the medullary Oil does not all guſh out together, but Stills forth in ſuch ſmall quantities, that it is ſome time before it flows all out, nay if the Bag be gently preſt, ſo as not to break the *Veſiculæ*, it empties it ſelf but gradually, and that becauſe after the Membrane of the larger Bag is broken, the medullary Oil is ſtill contained within the *Veſiculæ*, out of which, whilſt they are entire, but ſuch a quantity of it flows forth at a time, as their Pores will permit to paſs through them.

They ſeem to have Pores or immediate paſſages out of one into another, (and ſo do the Bags) by which the Oil has a free courſe to the Joynts, and ſubſtance of the Bone, for whoſe benefit it was deſigned, even from the middle part of that Maſs, which fills the large Cavities, and lies at ſome diſtance from the ſide of the Bone as well as from the leſſer Cells; and therefore in melting of a large piece of the hardeſt Marrow over the Fire, the Oil will by degrees all drop away, and leave the Bags, and *Veſiculæ* empty, which ſhews ſome paſſages from the internal part to the ſuperficies. And if we conſider the diſtance of the Bags, and *Veſiculæ* in the Centre of the Marrow in the large Bones, as ſuppoſe in that of the Thigh, from the ſubſtance of the Bone, and the Articulations, which it is to be ſupplied to, we muſt conclude that that there is ſome contrivance for the conveyance of it to thoſe parts, otherwiſe all the medullary Oil, beſides that, which is contained in thoſe *Veſiculæ*, which lie next the common Membrane, would be of no uſe to thoſe parts, for whoſe benefit it is intended. It being certain therefore that there is a motion, and paſſage of the Oil in the *Medulla* from one part to another, this muſt be either by proper Ducts deſigned for this end, or elſe by Pores formed in the Veſicles, by which the Oil flows immediately out of one into another, and ſo ſucceſſively, till it arrives either at the Joynt, or the ſubſtance of the Bone. By the ſtricteſt enquiries I have made I could never diſcover any thing like Ducts, neither have I indeed been able to obſerve the Pores, by which I make the medullary Oil to have its paſſage. So that thus far one may ſeem as probable as the other. But I ſay no. For if there were any Ducts leading from the ſeveral Glandules, we ſhould have them, as in other Glands, meet in larger Channels, which would be viſible, but the Pores are every where very ſmall, and there is no reaſon they ſhould be larger in one place than in another, ſo as to offer themſelves to our ſight. Beſides, let us conſider, that the Oil is not carried from the Veſicles, or Glandules to one large Receptacle, which would require the convenience of Ducts to convey it thither, but flows out of the ſuperficies of the Marrow in as many places as there are tranſverſe Pores in the internal *Lamell.* So that we muſt ſuppoſe theſe Ducts not only to be almoſt innumerable in their firſt riſe from the Glandules, but even in their termination, which it is hard to conceive, as it is unneceſſary, and is not agreeable to the wiſe methods of Providence, when there may be a more eaſie, and ſimple way for the conveyance of the medullary Oil, as the Veſicles in every Bag, and the Bags in the common Membrane do lie contiguous to one another, which affords the convenience of forming ſuch immediate paſſages out of one into another, as I have ſuppoſed.

The Bags, and glandular Veſicles are without doubt propagated from the Blood-Veſſels, ſince as I ſaid of the common Membrane, there are no other parts within the Cavities, from whence they can be derived, and they ſeem to be not only particularly from the Arteries, but from their exterior

Coat. Their membranous ſubſtance is in the ſame manner like the common Membrane, tranſparent, and their texture ſeems to be every way the ſame. So that I conceive that the exterior Coat of the Artery expanded, and conveniently modified makes the Veſicles, and being afterwards farther expanded, it produces the Bags, and from the expanſion of it beyond all theſe ariſes the Membrane, which includes the whole.

Beſides the preſſure of the medullary Oil, which is continually ſupplied, upon that, which was before ſeparated, and depoſited in the Veſicles, to drive it on towards the ſubſtance of the Bones, and towards the Joynts in ſome of them, we have ſome reaſon to think, that when the *Veſiculæ*, and the larger Bags are filled to a convenient diſtention, they contract themſelves, as the Fibres of the Bladder, and ſuch membranous Cavities evidently do upon the ſame occaſion, whereby being like a Sponge compreſt, the Oil is ſqueezed and forced out of one Veſicle, and out of one Bag into another ſucceſſively, whereby that part, which is contained in the Veſicles, that lie next the Membrane, is driven through it, and into the tranſverſe Pores of the firſt internal Plate, and that, which was more remote, is carried on towards it, and ſupplies the place of what is removed. And how it is diſpenſed after it comes into the ſubſtance of the Bone I have already ſhewn, when I gave an account of two ſorts of Pores formed in, and between the Plates.

But I have one thing here to give an accout of, and that is the paſſage of the medullary Oil to the Joynts. The manner, in which it paſſes, whilſt it is within the Bags, and Veſicles I have explained, but what contrivance there is for its exit out of the Bone, and its flowing into the Interſtices of the Joynts I am now to conſider, as it is evident, that it has a paſſage into them. For if any Joynt be preſerved entire till all the mucilage is waſted, there is to be found even in the Fingers, where I have not been yet able to diſcover any large paſſages, for a long time after an Oil tranſuded and ſticking to the ends of the Bones, which is ſupplied from their Cavities after a Man is dead, where even Death it ſelf leaves a ſtock to maintain the current of it into the Joynts, whereas the ſeparation, and ſupply of the Mucilage ceaſes as ſoon as the Circulation of the Blood is ſtopped, and that, which is left in the Joynt is quickly evaporated, or ſome other way diſappears. For this end there are Pores or paſſages formed both at the extremity of the Bone, and in the Sinuſes of it, which are on one ſide. Thoſe, which are at the very end, which ſeems cartilaginous, are very ſmall, but numerous, which in moſt Bones it is very difficult to diſcover; but I have a Bone of a Horſe, where they are very plain. And here I take the paſſage of the medullary Oil to be in the ſame manner as where the Plates lie contiguous in the ſides of the Bone, by tranſverſe, and longitudinal Pores. Some of the paſſages in ſome Sinuſes are very conſpicuous, particularly in the Cavity on the hinder part of the *Os Femoris*, at the Ham there is one, which I opened, and traced for ſome way up into the cavernous part of the Bone, and in the large Cavity on the hinder part of the *Trochlea* of the Shoulder-bone there are in moſt Skeletons ſeveral, ſometimes ſix or ſeven, one whereof is larger than all the reſt, and I did particularly examine one, that was conſiderable, firſt with a Briſtle, whereby I found there was a clear paſſage down a great way into the Bone, which when I opened, appeared to be a bony Duct, that ran for ſome way into the cavernous part, which beſides what it had at its termination, had on every ſide ſeveral Pores, by which it opened into ſo many of the Caverns. And in the ſame Cavity in the *Os Humeri* of a Horſe I have found eight or nine of theſe paſſages pretty large, with ſeveral others, which were viſible to the naked Eye. Now by theſe Pores the medullary

Oil ſeparated in the Cavities flows into the Duct, and by that into the Interſtice of the Joynt. The paſſage of this Duct, where it opens into the Joynt, is in ſome Animals very large, in a Calf where it was ſingle, I obſerved it to be larger than that, through which the medullary Veſſels paſſed into the Cavity. And in fatted Beaſts, ſo without doubt in ſome Men, who are very Corpulent, there lies often over it ſomething like a Fat Gland fixed as it were by a Root into this paſſage, which at firſt I was apt to think was indeed ſuch a Gland, till I came to make a ſtricter enquiry, and found from whence that Fat was ſupplied. For as the adipoſe Glands between the Muſcles, ſo the Veſicles of the Marrow may often ſupply a greater quantity of Oil, than is expended, and where the Animal is fatted, and little exerciſed in motion, as thoſe, which are deſigned for ſlaughter, are excuſed from Labour, there is more ſupplied, and leſs made uſe of than in ſome others, ſo that it is not ſtrange to find ſome of it ſticking, upon the Bone, and a ſuperfluity of it even in the Joynt.

I ſhall not here ſtay to give any account of the nature of that matter, which is contained in the Bags, and Veſicles, which I have deſcribed, when every one knows it to be an Oil: nor is it neceſſary I ſhould ſay any thing concerning the manner how it is ſeparated, ſince what I have ſaid of glandular Secretion in general, is ſufficient to explain it.

There is one thing or two, which I ſhall take notice of, before I proceed to ſpeak of the uſes of the medullary Oil; the firſt is the difference there is between the colour of that part of the Marrow, which is in the large Cavities, and that which is in the bony Cells eſpecially in ſome Animals, the one being where it is indurated of a whitiſh colour mixed with a red; the other plainly red. This diverſity in their colour proceeds from a difference in the number of their Blood-Veſſels. For in that part of the Marrow, which is lodged in the large Cavities I do ſuppoſe, that every Veſicle has not an Artery to convey the Blood, which ſupplies the oily Particles, to it, nor a Vein to carry it back, but there are ſome, which by Pores have that Oil, that fills them, ſupplied from other Veſicles, that ſerve for the ſeparation of it, but thoſe Veſicles, which are in the ſmaller Cells, have every one of them their Blood-Veſſels for this end, which makes them proportionably more numerous, and that part conſequently more red. The ſecond thing is the different conſiſtence of ſeveral parts of the Marrow, when they are cold. In the large Cavities of ſome Bones, we ſhall have ſome, which after it is cold is indurated, and of the nature of a Sewet, ſome of it remaining liquid, even in the ſame Cavity. Now Oil in its proper and natural conſiſtence is liquid as well when it is cold as hot: So that that part of the medullary Oil, which remains ſo, ſhews it ſelf to be more pure, and unmixed; the other, which is congealed, has the addition of ſomething to it, which alters its conſiſtence, and what parts theſe are we can learn from nothing better than an experiment, in which ſuch a change is effected in common Oil; and this I have borrowed from the moſt ingenious Dr. *Grew*, who in his Diſcourſe of the power of Mixture tells us how the Fat of an Animal Body may be imitated: *Which*, ſays he, *may be made thus, Take Oil* Olive, *and pour it upon high Spirit of* Nitre, *then digeſt them for ſome days. By degrees the Oil becomes of the colour of Marrow, and at laſt is congealed or hardned into a white Fat, or Butter, which diſſolveth only by the Fire, as that of Animals. In converting Oil thus into Fat, it is to be noted that it hardens moſt upon the exhalation of ſome of the more Sulphureous parts of the Spirit of* Nitre. — *Hence the true congealing Principle is a Spirit of* Nitre.

—— And *The making of Fat is but the durable congelation of Oil.*

Hence alſo it appears that Animal Fat it ſelf is but the curdling of the Oily parts of the Blood; either by ſome of its own Saline parts, or by the Nitrous parts of the Air mingled therewith.

The reaſon therefore of the difference in the conſiſtence of ſome parts of the Marrow, and of the congelation of that, which is found indurated, when it is cold, is the mixture, and combination of the Nitrous parts of the Air with it, fixing the Particles of it; which do it ſo effectually, that if any of the indurated Marrow be diſtilled *per ſe*, it will after it is brought over, and cold, return to its former conſiſtence. Though afterward, by ſetting of it long in the Sun, I brought ſome of it to the nature of a true Oil, which remained liquid when it was cold.

Of the USES of the MARROW.

I Shall in the next place give ſome account of the uſes of the Marrow: the uſes of it I ſay, becauſe it ſerves for more than one, though that can be none of them, which Authors ſeem to aſcribe to it, when they make the medullary ſubſtance, which lies between the two Tables of the Skull to ſerve for the Nouriſhment of it. For beſides that the Bones have evidently Blood-Veſſels deſigned for their Accretion, which properly belong to their ſubſtance, and are no ways concerned with the Marrow; to any one that conſiders the nature of the *Medulla*, that it is an Oil, it will plainly appear, how uncapable it is of being converted into ſo ſolid a ſubſtance as that of a Bone. Yet if they will ſuppoſe Nutrition to be only a ſupply of Volatile, and Fluid Matter to maintain the fulneſs, and to preſerve the Tone, and temperament of the containing parts, the medullary Oil may be ſaid to be concerned in their Nutrition, as it is continually ſupplied to repair the loſs of that Oil, which is expended.

The uſe of it is in the firſt place general, and common to all the Bones, and to the whole of every one of them, and ſecondly more particular to ſome parts of ſome of them. It oils the whole ſubſtance of every Bone, and by its unctuoſity preſerves them in a due temperament. Their parts are naturally dry in themſelves, and when they obtain too great a degree of ſiccity they are more fragil, and apt to be broken by any violence, and not only ſo, but we find how ſoon the thin part of the *Scapula*, where there is no *Medulla*, will without any violence crack, merely by its own dryneſs, when it is expoſed to the Air. So that it was neceſſary for their ſecurity againſt Fiſſures, and Fractures, that they ſhould be defended by ſuch a Matter, as may help to retund the violence of thoſe accidents, which are apt to injure them, and ſo mollifie their parts as to make them capable of yielding a little to thoſe preſſures, and that force, which would otherwiſe be more eaſily, more inevitably, and more ſenſibly injurious.

Beſides this general uſe of the Marrow, the ſervice of it is more particular to the extremities of thoſe Bones, which are articulated. Firſt, for their lubrication, to fit them for the great, and neceſſary buſineſs of Motion, to preſerve them always in a condition fit for it, and to make them more ready to alter their

Poſition, when there is occaſion. It is true the ends of theſe Bones, which are articulated are very ſmooth, but yet if they were dry, they would not with that readineſs and facility obey the commands of thoſe Muſcles, which move them. Wherefore Nature has taken care to lubricate them with a ſlippery Oil, to which, when it flows into the Joynt, is added a mucilaginous Liquor ſeparated by peculiar Glands ſeated in the articulations, and from the mixture of theſe two, an Oil, and a Mucilage, is made a compoſition ſo fit for this deſign, that nothing taken from the vaſt ſtock of Nature ſeems comparable to it, as I ſhall ſhew, when I come to ſpeak of the Glands, which ſeparate the Mucilage.

Secondly, The medullary Oil in conjunction with a Mucilage preſerves the ends of the Bones, which are articulated, from an Incaleſcence, from contracting an inordinate heat by their Motions, which would otherwiſe be the effect of them, eſpecially when they are very quick, and violent, and long continued. It is impoſſible that two Bodies ſo ſolid as the Bones in ſome parts are, and the extremities of thoſe, which are articulated, would be without the benefit of ſuch a Matter, as both mollifies them, and intervenes ſo as to keep them from an immediate contact, ſhould be violently moved, and rubbed one againſt another without creating a great heat. This every Coach-man, every Car-man is ſenſible of, and therefore they have their Oil, and Mucilage, a Compoſition, in which they imitate this of Nature, that is a mixture of Greaſe, and Tar, with which they beſmear the inſide of the Naves of their Wheels, and the extremities of the Axis, upon which they move, without the benefit of which the ſwift Rotation of one about the other produces a heat, and that ſometimes ſo intenſe as to ſet them on fire. And if there had not been a proviſion in the Joynts againſt ſuch a preternatural Incaleſcence upon their violent Motion, this would have made a ſlothful World, and have confined us to ſlow, and deliberate movements, even when there were the moſt urgent, and haſty occaſions to quicken us.

Thirdly, It was farther neceſſary that the Bones ſhould be oiled, and moiſtned with ſomething of this nature in their Joynts to prevent their Attrition,or wearing by rubbing one upon another. For without it we cannot but be ſenſible, and certain of this, that two Bodies of the nature, which the Bones are of, being frequently, and as ſome of them often are, violently moved one upon another, muſt inevitably be mutually injurious, and ſome of the parts muſt be worn off on both ſides. So that the contrivance of Nature to adapt one Bone to another in all the articulations, to fit them for an eaſie motion and that variation of their poſition, which is requiſite in every Joynt, how admirable ſoever it might ſeem at firſt, would not be long uſeful, but the ſtirring part of Mankind would ſoon find themſelves fitter for an Hoſpital, than for Action, and the purſuit of Buſineſs.

Thus it appears how beneficial, and abſolutely neceſſary the medullary Oil is to the Bones, but the uſe of it extends it ſelf beyond theſe parts firſt to the Ligaments, which tie them, that are articulated, together, theſe it preſerves from dryneſs, and rigidity, it keeps them pliable, and ready to conform to all the motions and poſtures of that moveable part, to which they appertain. Were they not thus oiled, we may eaſily be ſenſible how different their temper would be from what it now is, from the rigidity, which they contract, when they are laid in the Sun, and dryed. And why may we not alſo ſuppoſe, that it is as uſeful, and for the ſame reaſon neceſſary to theſe parts, as Oil to Fiddle ſtrings, which the Muſicians make uſe of to preſerve them from that aptitude to break, which otherways they will have, when they are much extended. So to ſecure theſe Ligaments from a diſruption, which as ſtrong as they ſeem to be, they would be in danger of upon a great, and ſudden ſtretch, or contortion, if they were dry, they are oiled and moiſtned with this mixture of the medullary Oil, and the Mucilage.

And as it preſerves the temperament of the Ligaments as well as that of the Bones, ſo it ſerves likewiſe for their lubrication. Some of them are faſtned to the Bone at ſome little diſtance from the extreme part of it, that they are diſtinct, and ſeparate from ſome part of the ſide of it, which they lie upon, ſo that in all the motions of the Joynt they not only are inflected or extended, but they ſlide backwards, and forwards upon the Bone. Now being contiguous to it, and ſlipping upon it, there does appear a reaſon for, and a neceſſity of ſomething, which may lubricate them, which might make their motion upon that part of the Bone, where they ſlide, more ready, and facil. And from the ſuppoſition of a defect of that, which ſhould make them ſlippery, we may account for the cracking of the Joynts, which is frequently to be obſerved in ſome Scorbutical Perſons, where I do think that the Ligaments more than the Bones are to be accuſed. For if they are not ſufficiently lubricated, they will not be ſo ready to ſlip that way, which the motion of the Joynt commands them, and whem they do not ſlide proportionably, and by a continued motion anſwer to that variation, which is made in the poſition of the part, they muſt needs, if they make any ſtop, when the Joynt perſiſts in its motion, be extraordinarily extended, which ſeems to be the occaſion of that pain, which is then often felt, and is one thing that makes me think, that the Ligaments have ſome ſenſe. But being uncapable of ſuch an extenſion, as will without their motion give the part the liberty of being extended, or inflected to that degree, to which the Muſcles by their contraction oblige them to move, (which would be inconſiſtent with the due conjunction of the Bones) when they can give way no farther by their extenſion, they are forced at laſt to ſlip, and that with ſuch a quickneſs, as makes the ends of the Bones ſtrike one againſt the other with a ſudden violence, which impreſſes ſuch a motion upon the Sonorifick Particles of the Air, as affects our ſenſe of hearing. Although it is probable that there may be another reaſon for this cracking of the Bones ſometimes, and a different affection of the Ligaments to occaſion it, that is too great, and a preternatural laxneſs in them, whereby being more capable of an extenſion, they do not tie the Bones ſo cloſe, and ſtrictly together, as to keep down the proceſs or end of one firmly into the *Sinus* or Cavity of the other, though the relaxation be not near ſo conſiderable as to diſpoſe the Bone to any thing like a Luxation. Now ſuppoſing one to riſe from the bottom of the *Sinus* in the other, in the motion of the Joynt the end of one Bone may be pitched againſt ſome lateral part of the Cavity, and move upon that as its Axis, and every little irregularity in the poſition of it, makes it uncapable of moving ſo as at the other extremity to deſcribe ſo much of a Circle as the contraction of the Muſcles will oblige it to do, without a reſtitution to its natural place, which not being done without ſome force, it falls down with a violence, and velocity into the bottom of the *Sinus* of the other Bone, where they ſtrike one againſt the other in ſuch a manner, as to make a ſound.

The medullary Oil ſeems to be ſerviceable to ſome other parts, beſides thoſe, for whoſe benefit it is evidently employed, and where I have ſhewn the uſes of it, and I cannot but think, that it is communicated from the Bones, in which it is depoſited, to thoſe Cartilages, which are joyned to them, and that for ſome neceſſary end. Beſides that the Bones are there ſofter, than where the Plates are contiguous in their ſides, and there is nothing intervenes to prevent the paſſage of this Oil out of one into the other, there are Pores both in that end of the one and of the other, where they are joyned together, which allow the paſſage of it, and ſeem deſigned for this purpoſe. And I have, when they have been relaxed with the heat of the Fire, obſerved on Oil, which had inſinuated it ſelf, and ſtuck to the end both of the Bone, and of the Cartilage. Theſe parts it preſerves from growing dry, and maintains their flexibility, and how neceſſary it is, that they ſhould be moiſtned with ſomething of this nature, appears from the hardneſs, and rigidity, which follow upon their being dryed.

The FOURTH
DISCOURSE
OF THE
Mucilaginous Glands.

I Proceed in the next place to give an account of a particular ſort of Glands ſeated in the Joynts, which, whilſt I was making ſome obſervations of the ſeveral parts, which belong to and make an articulation, I came to take notice of, which ſeparate a mucilaginous kind of Liquor, and are no where deſcribed, nor have ever, that I know of, been obſerved by any one, only ſome time after I had made my Obſervations of them, I met at Surgeons Hall with an indefatigable, and curious Anatomiſt, one Mr. *Cooper*, an ingenious Surgeon of this Town, who had taken particular notice of the larger ſort of theſe Glands.

After I had conſidered the nature of that Liquor, which preſents it ſelf to our Obſervation in the Interſtices of the Joynts, which I always found to be mucilaginous, I began to think with my ſelf, that as it was vaſtly different in its Nature from the Marrow or an Oil *per ſe*, though it might have the acceſſion of an Oil, it could not be all ſupplyed from the Cavities of the Bones, but muſt have ſome diſtinct and peculiar parts to ſeparate, and ſupply it, which gave me the firſt occaſion of enquiring, whether there were no Secretory Organs particularly deſigned for the ſeparation of it, and upon a ſtrict examination of the Interſtice, and the Membrane, which does immediately cover the Articulation, I firſt found in the *Sinuſes* of the Bones within the Joynt ſome ſoft parts, which to the touch ſeemed Veſicular, and ſpongious, and obſerved, that the Membrane not only was lax, but alſo unequal with protuberances of a different Figure and Magnitude. As it was looſe and eaſily extended, where the Ligaments would not ſuffer the ends of the Bones to recede from each other, it was evident that it was not inſervient to their Conjunction, nor was this uſe of it conſiſtent with an Articulation. For did the Membrane, which lies round the Joynt tie the Bones together, this muſt have fixed the part, which is to be moved, on every ſide, and have made it uncapable of a flexure, or any natural alteration of its poſition. The inequalities I obſerved preſently gave me the ſuſpicion of Glands, and when I came to make a farther enquiry, I found that the Membrane was truly glandulous, and that thoſe ſoft Bodies, which were in any of the *Sinuſes*, were Glands, and beſides the reaſon I had from the obſervation of them to think, that the Mucilage was ſeparated by them, I was fully convinced of the truth of this, when I expreſt ſome of it out of them.

Now becauſe they have not been taken notice of, nor obtained any name, and I ſhall have frequent occaſion to mention them, it will be convenient to impoſe upon them one, which may be proper, and diſtinguiſhing, and the parts, in which theſe are ſeated, and to which they are ſerviceable, ſuggeſt ſuch a denomination as *Glandulæ Articulares*, but becauſe I have obſerved the ſame ſort of Glands in ſome other parts, to wit between the Muſcles, and about the Tendons, and there are Glands ſeated in the Throat, which ſeparate a mucilage for the lubrication of our Food, and to make the deſcent of it into the Stomach more quick, and facil, I ſhall give them a more comprehenſive name, ſuch as *Glandulæ Mucilaginoſæ*, or the mucilaginous Glands.

In Treating of which I ſhall firſt give ſome deſcription of them, and an account of the Structure, and particular ſituation of thoſe, which are moſt conſiderable. Secondly, I ſhall conſider the nature, and deſign of the Liquor, which they ſeparate, and ſhew how ſo great a quantity of it, as is neceſſary for the uſe of ſo many parts, as it is employed in, is continually generated. Thirdly, I ſhall give an account of ſome Experiments I made with it, and of a Diſtemper or two, which owe their Original very much to the Mucilaginous Glands.

Theſe Glands are of two ſorts. Some are ſmall and numerous in every Joynt, which are ſet thick all over the Membrane, excepting where there are any large Glands, and they are all of an equal magnitude,ſo as to render it every where glandulous, which is not extraordinary in a Membrane, when we have Tunicles, which are evidently ſo, and the ſagacious *Malpighi* has diſcovered to us, that the *Tunica Vaginalis* of the *Teſtes*, the Membrane or *Capſula* of the Heart, the *Peritonæum*, and *Pleura* are all ſo. But in ſome parts of the Membrane, and in the *Sinuſes* of the Bones in the Joynts theſe Glandules are ſo Conglomerated as to form remarkable Glands, and theſe I am now to deſcribe. In ſome of the large Joynts there is only one, as in the *Acetabulum* of the

Thigh bone, which is a very conſiderable one. In ſome, as in the Knee there are four, or five. They have ſomething of a tranſparency, when they are not diſcoloured with Blood Veſſels. This they have from their Baſis for ſome way up towards their other extremity in Horſes, and ſuch large Animals, where they riſe any conſiderable height above the ſuperficies of the Membrane, but near to the upper part, and ſo to the very end they receive a red colour from their numerous Blood Veſſels. But in Men they are generally every where of a red colour, which is more intenſe about their termination. They are ſoft, and pappy, but not tender and friable like the glandulous ſubſtance of the Liver, and ſome other Glands of the Body, ſo that they are not eaſily broken by a compreſſion, againſt which injury it was neceſſary in their Nature to fortifie, and ſecure them, becauſe they are ſeated amongſt ſuch parts as are obdurate, and preſs upon them in their motion, though it be ſo lightly as not plainly to compreſs them. Neither are the parts of theſe Glands very eaſily pulled aſunder, and perhaps the mucilaginous quality of the humour, which they ſeparate, may both make their parts flexible, and give them a diſpoſition to adhere to one another, all which oppoſes their friability. As for their Stucture I had a very good opportunity to enquire into it in ſome of them, which I took out of the Joynts of a Horſe, that were Hydropical, and filled with a preternatural humour, which diſtended their Glandules, and made them appear very fair with the help of a Microſcope, one whereof was as large as a Man's Hand. They are, as I have ſaid before, Conglomerate, though they do not conſiſt of ſeveral *Lobules*, or Bags of leſſer Glandules, as ſome other Glands do, but of ſeveral Membranes superſtrated one over another, ſet thick with ſmall round Bladders, which not only lie contiguous, but tenaciouſly adhere one to another, as the ſeveral Membranes likewiſe do. And by examining the Mucilaginous Gland in the *Acetabulum* of the *Coxendix* of a Man, after it was dried, I found, (though I did not queſtion it before) that the Structure of theſe Glands is the ſame in Men as in Beaſts; for I could diſcern ſeveral diſtinct Membranes, and divide them, which were ſix or ſeven in number. So that though the Glandules are here conformed to thoſe of the Marrow, the Lungs, and of ſome other Glands ſo far, as to be of the nature of Veſicles; yet the order, in which they are diſpoſed, is very different. By the Pores of theſe little Bladders the mucilaginous Liquor, is percolated and diſtinguiſhed from the reſt of the Maſs of Blood, which is conveyed to them by the Arteries, and from them it flows into the Interſtices of the Joynts by the Excretory paſſages, which all theſe Glands have. Blood-Veſſels they have a ſufficient number of, which, as I obſerved before, towards the Apex, or termination of them are more numerous, and make them look of a redder colour, than at their Baſis. Their Veins have not a direct courſe, but proceed obliquely with windings, and it is a pleaſant ſight to ſee the *Anaſtomoſes* of ſeveral of theſe ſmall Veſſels and their various flexures as they run along in the Gland. There ſeems to be a particular reaſon for the obliquity of the Veins in theſe Glands, from the nature of the Liquor, which they ſecern: For the Liquor, which theſe Glands ſeparate, obtaining a mucilaginous quality, the Particles of it do not ſeem to paſs through the glandular Pores with any great expedition, and therefore theſe Veſſels are formed with ſuch windings, that the return of the Blood by them may be ſomewhat retarded, and the Particles, which are to be ſeparated, may have more time to penetrate the Pores of the Glandules. The figure of the mucilaginous Glands is various, and accommodated to the *Sinus*, or Cavity, in which they are ſeated. Some are not only long but broad at their Baſis, and grow narrow towards the top ſo as to terminate in an edge; ſome have a broad

Baſis, and riſe into a ſort of a Cone; ſome are like little Ridges, ſome like a *Fimbria*, ſome are broad, and pretty flat.

As for their ſituation, they are differently ſeated in the ſeveral Joynts; in ſome they ſtand over againſt the very Interſtice of the Bones, and run in a little way between them, where the ends of the Bones towards that ſide are not contiguous, but ſo formed as in their Conjunction to make an Interſtice, and theſe are commonly in the manner of a *Fimbria*; ſome are ſeated in ſome *Sinus* or Cavity, others planted upon the Membrane, which immediately covers the Articulation. In general they are ſo ſeated, that they cannot be injured by a compreſſion from the Bones, and yet there is this contrivance, that the Bone does either in the inflexion, or extenſion of the Joynt lightly preſs upon them, ſo as to promote the Excretion of the Humour, which they ſeparate, into the Joynts, when they are moved and ſtand moſt in need of it. And by this means it ſeems to be moſt plentifully ſupplied, when there is occaſion for the greateſt quantity of it, and to be proportionated to the preſent exigence, according to the quieſcence, or ſeveral degrees of Motion in the part, when it is moved. And it is no ſmall ſecurity to theſe Glands againſt the obſtructions, which the mucilaginous quality of the Liquor, that they ſeparate, does naturally diſpoſe them to, that they are ſolicitated, and the Liquor expreſt out of them by the motion of the parts, where they are ſeated.

But I ſhall give a more particular account of the ſituation of the large, and conſiderable mucilaginous Glands in the ſeveral Articulations. I begin with that of the *Os Occipitis* and the Atlas, where there are ſome of theſe Glands planted round the Tooth-like proceſs of the *Epiſtropheus* the ſecond *Vertebre* of the Neck, and one on each ſide. In both the Articulations of the Ribs with the *Vertebres* they are likewiſe to be found, but the largeſt is in the lower Articulation, and on that ſide, which is next the Cavity of the *Thorax*. Theſe are but ſmall Glands abſolutely, though they are of the larger ſort, that is, they are formed of ſeveral Glandules conglomerated, and lying one upon another in ſeveral Membranes, and ſo to be diſtinguiſhed from thoſe that are but ſingle Glandules, which only ſtand one by another in the Membrane of the Joynts, and make no conſpicuous inequalities in it. In the Joynt of the Shoulder there is a conſiderable one joyning to the upper brim of the *Acetabulum* of the *Scapula* juſt by the tendinous Origination of the *Muſculus Biceps* on the foreſide of it, which runs downwards upon the Membrane for ſome way towards the

Arm-pit. And on the other ſide of that Origination there is another at a little diſtance from it. In the Cubit there is one Gland ſeated in the Cavity, which is on the hinder part of the *Trochlea* of the *Os Humeri,* and another large and fair one, in one of thoſe *Sinuſes,* which are on the foreſide of the ſame *Trochlea*, which I have given a figure of Fig. I. Tab. II. And upon the *Radius*, and *Vlna* there are ſome of them, which lie like a Ridge. At the Articulation of the Bones of the Cubit and the Wriſt there are a row of theſe Glands, or one of them lying like a Ridge of little Hills from one ſide to the other on the back part. On the inſide there are ſome, but not ſo conſiderable. At the Bones of the *Carpus* there are ſome, which are like a *Fimbria.* The *Acetabulum* of the *Coxendix* has one of the largeſt of this ſort of Glands in the whole Body. Where, becauſe the Cavity is deep, and the *Supercilium*, which goes round the brims of it, runs ſo far over the head of the Thigh bone, and lies ſo cloſe to it, that the Mucilage could not have plentifully inſinuated it ſelf into the Cavity, nor readily have been diffuſed for the Lubrication of the head of the Bone, which is received into it, if the Gland had been ſeated, and the Mucilage ſeparated out of that Cavity; therefore the Gland, which ſupplies it to this Joynt, is placed within it, and lies between the extremity of the head of the *Os Femoris*, and the *Coxendix*. But as this was neceſſary, ſo on the other hand there was a difficulty, and an inconvenience, which without the Providence of Nature, would have attended this ſituation of it: For if the Cavity had been every where fitted to the head of the Thigh-bone, which it receives, without a particular regard to this Gland, and the Gland had been placed within it, as now it is, it would neceſſarily eſpecially in a ſtanding poſture have been compreſt to the deſtruction of the tone of its Glandules, and ſo have been rendered uncapable of performing its Office; therefore there is a *Sinus* or Cavity at the bottom of the *Acetabulum* formed on purpoſe to receive, and ſecure it beyond the injurious preſſure of the Thigh-bone. This Cavity is in a human Skeleton almoſt of an Oval figure which I have found an Inch and five eighths in length, and in the wideſt place very near one Inch one eighth in breadth, and about three eighths of an Inch deep, occupying at one end, and on both ſides only the bottom of the *Acetabulum*, but at the other end it runs up by the Ligament, which is inſterted into the tip of the head of the *Os Femoris* to the brim of the Cavity. In the Knee there are of theſe Glands both before, and behind, above the *Rotula* there is one, and at the bottom

tom of it another, which is a very conſiderable one, and on one ſide another, that is leſs, all which I have given a figure of Fig. II. Tab.II. where *A, A, A, A,* are the fore part of the Knee taken off with the *Patella,* and the inſide turned up, and laid in view: *a, a, a,* are the large mucilaginous Glands: *b, b, b, b,* the Membrane which immediately covers the Interſtice of the Joynt, and *c,* is the *Patella.* As for the Glands of the Fingers and Toes they are ſeated on the inſide, or bending part, where they are like a *Fimbria,* and in every Joynt there are two of theſe glandulous *Fimbriæ*, one belongs to the remoteſt or that which is the moving Bone, when the poſture of that Joynt is altered, and is ſeated juſt at the edge of its extremity; the other is planted upon the Bone, with which the other is articulated at a little diſtance from the extreme part of it, up in a *Sinus,* formed as well for the reception of that Gland, as to give the other Bone, when it moves that way, the liberty of ſliding towards it, and of being inflected, at which time it makes ſome little preſſure upon it. And now let any one conſider the ſituation of all theſe Glands, and he will be ſenſible, how they are ſeated, as I ſaid, ſo as to be lightly preſt, either when the Bone is extended, or inflected, to promote the Evacuation of the Mucilage out of them into the Interſtice of the Joynt.

And here I cannot but take notice, that I have obſerved the ſame ſort of Glandules in the *Membrana communis Muſculorum,* as thoſe, which occupy the Membrane, that lies over the Joynts in all that part, which has none of the large Glands; and amongſt many of the Tendons, there are ſeveral of the larger Glands, or the leſſer Glandules conglomerated into the form of Glands. So that I dare be poſitive in this aſſertion, that the common Membrane of the Muſcles is every where glandulous. For in that Subject, where I had ſome hydropical mucilaginous Glands, I found ſeveral parts of the Membrane of the Muſcles in the ſame manner hydropical, where it not only upon an ordinary view appeared like the hydropical mucilaginous Glands, which I took out of the Joynts of the ſame Subject; but when I came more ſtrictly to examine the Structure of it with the help of Glaſſes, which the fulneſs, and diſtention of the Glands gave me a fair opportunity of doing, I found, that as it had ſmall Veſicles or Glandules, ſo were they exactly like thoſe of the mucilaginous Glands of the Joynts; there was only this difference, that the Glands conſiſted of more Membranes.

From the obſervation of theſe Glandules, and that hydropical fulneſs, and ſwelling of them, which I met withal, I cannot but conclude, that when we have a Dropſie about the carnous parts the common Membrane does ſometimes contribute to it, and that there is now and then a particular Dropſie between the Muſcles, where the water is ſupplied by theſe Glands only, part of which flows out of them into the Interſtices, and part is retained in the Veſicles, which diſtends them in an extraordinary manner, and by making a great, and preternatural addition to the thickneſs of the Membrane, produces a ſenſible ſwelling in the part.

The larger ſort of theſe Glands about the Tendinous parts are very eaſie to be diſcovered, and remarkable in thoſe Beaſts, which are of a conſiderable magnitude, eſpecially where there are any long Tendons, which ſlide backwards, and forwards in a *Sinus* upon the contraction and extenſion of their Muſcles.

Of the Nature and Uſe of the

MUCILAGE.

THE uſe of the Glands, which I have now deſcribed, in general is the ſame as that of all Glands, that is, they ſerve for the percolation, and ſeparation of ſome Matter, and they do particularly ſupply a Liquor, which is neceſſary for facilitating the actions of thoſe parts, where they are ſeated.

The Liquor ſeparated by them is a Mucilage, which is almoſt like the white of an Egg, though it is not always ſo clear, and limpid; yet when it is pure, it has the reſemblance of it; in ſome Beaſts I have obſerved it to have a yellowiſh colour, as if there were a portion of Bile in it. It is evidently ſaltiſh to the taſt, and conſiſts of Aqueous, Saline, and Gummous, or ſuch Terreſtrial parts, as have no rugoſities or inequalities, nor hamous extremities, ſo that they are apt to ſlip one upon another, but withal they have ſo much of an immediate contiguity, as makes them in ſome degree adhere, which gives them ſomething of a Viſcoſity, or mucilaginous quality. The Salt, and Terreſtrial parts I have found to be about a two and thirtieth part of the Compoſition, which is more than ſuch a proportion as that muſt be of Gum Arabick, or Tragacanth, which with fair water will make a Mucilage of the ſame conſiſtence. The nature of the Mucilage ſeems to be very much like that of the ſerous part of the Blood, which ſhews it ſelf diſtinct from the fibrous parts or *Coagulum,* after it has ſtood ſome time expoſed to the Air, and ſeveral mixtures will produce the ſame effect; in both. And it is not ſtrange, that one has ſo much of the nature of the other, when the Mucilage is ſupplied from the Blood, and is without doubt a part of the *Serum.* But yet that there is a difference appears in that the *Serum* is not ſo mucilaginous, and from ſome experiments, for the *Serum* of the Blood will be more remarkably coagulated with Spirit, and Oil of Vitriol, with Spirit of Salt, and Oil of Sulphur, and when they are held over the Fire in a Spoon the effect is very different, the *Serum,* as it is known, will in a manner turn wholly to a thick Jelly or Size, which is friable, inſomuch that of a Dram I have had, after it had loſt its fluidity, two Scruples, and ſixteen Grains, and after it was throughly dried five Grains and a half, which is very near the eleventh part, whereas the Mucilage with the heat of the Fire turns for the greateſt part into a Liquor more tenuious, than it is it ſelf naturally, and produces only a thin film upon the top with ſome little white *Coagulum*, and what remains after the aqueous parts are all perfectly evaporated is not a thirtieth part.

The uſe of this Mucilage is principally to lubricate the Joynts, to render and preſerve the ends of the articulated Bones ſo ſlippery, that the Animal may move, and manage thoſe parts, as there ſhall be occaſion with the greateſt facility. This ſeems to be the great, but it is not the only thing, that lubricates the articulated extremities of any Bones. For beſides the Liquor, which is ſupplied by the mucilaginous Glands, which I am now ſpeaking of, there is an oily ſubſtance tranſmitted from the Cavities of theſe Bones into the ſame Receptacles or Interſtices by paſſages formed for this end, as I have ſhewen in my Diſcourſe of the Marrow. Theſe two meeting in the Joynt are mixed together, eſpecially upon the motion of the part. And certainly there is no Liquor, nor any mixture can be thought of more proper for this end, than this is, where not only both the Ingredients are of a lubricating nature; but there is this advantage from the Compoſition, that they do mutually improve one another: for the Mucilage adds to the lubricity of the Oil, and the Oil preſerves the Mucilage from inſpiſſation, and contracting the conſiſtence of a Jelly. And here we cannot avoid the notice of the viſible footſteps of an infinite Reaſon, which as they are deeply impreſt upon the Univerſe, ſo more eſpecially upon the ſenſible parts of it in thoſe rational contrivances, which are found in Animals, and we can never ſufficiently admire the Wiſdom, and Providence of our great Creator, who has given all the parts in theſe animated Beings not only ſuch a Structure, as renders them fit for their neceſſary Motions and deſigned Functions, but withal the benefit and advantage of whatever may preſerve them, or facilitate their Actions.

There are ſome other ends, which this Mucilage is inſervient to, as the preſervation of the extremities of the articulated Bones from Attrition, and an incaleſcence, but becauſe neither of them ſeems to be the firſt intention of Nature, in the Generation, and ſupply of this Liquor, and I have taken occaſion to ſpeak of theſe uſes, and how it ſerves to them in Conjunction with the medullary Oil in the preceding Diſcourſe concerning the *Medulla*, I ſhall take no farther notice of them, than to mention them.

As I have obſerved the mucilaginous Glands ſeated between the Muſcles, and about the Tendons,

dons, and a Liquor of that nature ſupplied to thoſe parts by them, ſo it is not to be doubted but the deſign, and principal uſe of it is the ſame as in the Joynts, to wit, to lubricate them. And when we conſider how the contraction of the Muſcles not only obliges their Tendons to approach towards their Origination, but draws up ſome part of every *Fibre* towards their beginning, ſo that they muſt neceſſarily move or ſlide backwards or forwards upon the part, which lies contiguous to them, (which is the *Membrana communis Muſculorum*) as they are contracted, or relaxed, and extended, we ſhall ſoon be ſenſible how neceſſary it is that the Muſcles ſhould be lubricated. And for ſome of the Tendons, which ſlip up and down in *Sinuſes*, as thoſe of the *Muſculi perforantes*, which are inſerted into the third or laſt Joynt of the four Fingers, and into the ſame Joynt of ſo many of the Toes, ſome of the flexors of the Leg, and ſome others, the Mucilage does appear as uſeful, and neceſſary to them, as in the Joynts, ſo that I need not go about to prove it.

Allowing therefore this Liquor, when it is ſupplied to the Muſcles, and Tendons, to be employed in their Lubrication, as it is at the extremities of the Bones, which are articulated, it will be no unreaſonable ſuppoſition to think, that there is the ſame kind of mixture in theſe parts, that there is the addition of an Oil to the Mucilage to preſerve it from inſpiſſation; ſince the nature of the Liquor is the ſame in both, there is the ſame reaſon in one as in the other, and the matter of Fact does in a manner appear, when we find ſuch vaſt numbers of adipoſe Glands, and ſuch quantities of Fat between the Muſcles in ſome Bodies, and in fatted Beaſts there are ſome of the adipoſe Glands to be obſerved about the Tendons, which move in a *Sinus*. Though ſuch a collection of Fat does not occur in all Bodies, yet that there are the ſame Glands in thoſe, that are Lean, does not admit of any diſpute, nor is it leſs certain, that they perform their Office and ſeparate a Fat ſo long as there are oily parts in the Blood, which in the Circulation of it, will offer themſelves to thoſe Glands. And although the reaſon of leanneſs in ſome Men may be, becauſe the quantity of Oil, which is ſeparated by theſe Glands, is not ſo great as in thoſe, that are obeſe, which ſeems to be the reaſon in old Men, in ſickly perſons, and in thoſe, that feed high, and uſe but little exerciſe, yet are of a thin habit of Body: yet that which makes the variation between fat, and lean Bodies, is often a difference in the expenſe of this Oil. The deſign of which being to aſſiſt in the Lubrication of the Muſcles, and Tendons, it follows,

lows, that it wuſt be more profuſely expended, where their motions are frequently repeated, or long continued. Therefore there are many in the World, as thoſe, whoſe Fortune condemns them to hard Labour, and have little Reſt but the Repoſe of the Night, that cannot ſhew ſuch larded Muſcles as ſome others can (as I do not know that ever I ſaw a Country Labourer Fat) who notwithſtanding have better Appetites, injoy ſuch a perfect ſtate of Health, and carry all the ſigns of the good Craſis of their Blood, that we have no reaſon to queſtion, but the Maſs of their Blood ſupplies that proportion of Fat, which would make them as Corpulent as ſome of their Neighbours, but that the laborious manner of their life makes them have ſome other occaſion for it, and the motion of their Muſcles is a way, by which it is continually expended, ſo that there is no overplus to be reſerved in the adipoſe Cells. And how often do we find an alteration in the plight of theſe Men, when they can indulge their eaſe, and allow themſelves in a more idle way of living? How evident is this in Horſes, which, whilſt they reſt, and are well fed, grow Fat, but when they come to be rid, or to work hard long together, ſpend all that ſtock, and loſe their Fleſh, as it is termed, ſo as to be almoſt a ſhame to a Market? That there is a greater expenſe therefore of the Fat upon great motions, and exerciſe is plain, the queſtion then will lie here, how this Oil is employed. Dr. *Mayo* ſuppoſes theſe ſulphureous parts to be ſeparated from the Maſs of Blood by the *Parenchyma* of the Muſcles, and by a congreſs with ſome *Nitro-aereous* Particles or the Spirits conveyed to them by the Nerves, mutually axagitating each other, and producing an efferveſcence to ſerve for the contraction of the muſcular Fibres, and in caſe the Muſcles are not frequently exerciſed, and contracted, ſo as to employ all thoſe ſulphureous, or as he makes them *ſalino*-ſulphureous parts, in their motion, and ſo to deſtroy them, that then they are conveyed by peculiar Ducts from the interior part of the Muſcle to convenient Receptacles, in which we afterwards find them collected in the form of Fat. And to ſtrengthen the probability of this Hypotheſis he urges this as an Argument that theſe parts are ſeparated in the *Parenchyma* of the Muſcle, that the Blood-Veſſels, which are diſſeminated through the Body of a Muſcle are never propagated ſo far, as the Fat, ſo that the parts, which conſtitute it, cannot be immediately ſupplyed from them to thoſe parts, in which we find it. But this Argument may be eaſily invalidated. For although it is true the Blood-Veſſels in the Fat are not ſo numerous, as in ſome other parts, yet there are ſome, which are viſible, and Glandules, which ſerve for the ſeparation of thoſe oily Particles. Beſides, I have obſerved ſome adipoſe Glands about the Tendons at a great diſtance from the fleſhy Fibres. And we find in the Cavities of the Bones a ſubſtance of the ſame nature, where it certainly is neither ſeparated by the *Parenchyma* of any Muſcles, nor concurring with the Spirits in their contraction, but ſome part of it is aſigned to the Joynts, where it meets with the Mucilage, which neceſſarily requires ſomething of this nature to preſerve it from inſpiſſation. Which if it be requiſite for this end in the Joynts, is no leſs in any other part, where the Mucilage is employed. But if theſe ſulphureous parts are expended, and deſtroyed in the contraction of the muſcular Fibres, then muſt they be wanting to this Liquor, when it is moſt plentifully ſupplyed, and there is the greateſt occaſion for them upon the external part of the Muſcle. So that I rather think, that the firſt intention of this Fat is to make ſuch a Compoſition, as is fit to lubricate the parts, and all the uſes of it are in Conjunction with the Mucilage.

Beſides the intention of Lubrication, the Mucilage with the addition of an Oil is farther neceſſary to the Muſcles, and Tendons, to preſerve them from ſhrinking, from growing dry, and rigid. Therefore in Rheumatiſms, when the nature of it is altered, and it contracts ſuch a viſcoſity, and thick conſiſtence, as render it unfit to moiſten theſe parts, we have a ſtifneſs, and Stupor, which I ſhall take farther notice of, when I come to ſpeak of that Diſtemper.

Of the Generation of the MUCILAGE.

HEre ſome may be ſo curious, and inquiſitive as to ask me, how the Mucilage is continually generated,and how the ſanguineous Maſs comes to be capable of ſupplying ſuch large quantities of it, as are neceſſary to lubricate ſo many parts, as it is conſtantly, though not always in the ſame meaſure ſupplyed to. I anſwer, that the matter, of which it is made, is originally from our Food, and the Chyle, which is daily added to the Maſs of Blood, as all other Juices are; but yet it is a great alteration, which theſe parts of which it is generated, do undergo, before they are reduced to the true nature of a Mucilage. The change therefore, which that part of Blood from which it is produced, undergoes in order thereunto, ſeems to be made by ſome Gland, and there is none, that I can think of, which ſeems ſo fit, and likely to be concerned in this affair, as the Spleen, which I ſuppoſe to be the *Officina,* where Nature ptoduces, and elaborates the Mucilage, from whence it is adminiſtred to the Blood, and by that diſpenſed in its Circulation to all the parts, about which it is neceſſary it ſhould be employed. This I have been thinking, that this large *Viſcus* is deſigned for ſuch an Office, that it is not abſolutely neceſſary to the life of Animals, ſince we find not only, that the privation of it is conſiſtent with Life, but that the Animal has ſeemed little concerned for the want of it. And this not only has been obſerved in Dogs, which are the ordinary Subjects of this experiment, but there are ſome, that tell us, if we may give credit to what they ſay, that it has been found wanting in ſome Men, and taken out of others, who have been reſtored to their Health by a happy Cure. Thus far this Gland, and the uſe, which I aſſign to it, agree, ſince the Office, which I ſuppoſe it does perform, is not ſo requiſite to the being, as the convenience, and well being of an Animal. For although the Mucilage did wholly depend upon the Function of this part, we may eaſily ſatisfie our ſelves, how it comes to paſs; that the Animal is no more injured by the want of it. For ſince the uſe, and deſign of it is to lubricate the parts, and there are no parts, about which it is employed, but have an Oil, that anſwers the ſame end ſupplied to them, the inconvenience, which we may ſuppoſe ſhould follow upon the want of the one, is very much taken off by the other, which is likewiſe of a ſlippery and lubricating nature. Though I am apt to think if the Animal, after it is deprived of the Spleen, were put upon great, and frequent motions, there would appear a more ſenſible injury from the want of it, and becauſe the Subjects, in which this Experiment is commonly made, have not been afterwards put upon ſtirring, but being fit for no farther uſe, or reſerved only for diſſection, have been allowed to lie at home, and to live a lazie, and ſoporoſe life, therefore they have had leſs occaſion for the Mucilage, and ſo have ſeemed unconcerned for the want of that part, which ſupplies it. And, as I make this an Argument for my Hypotheſis, that as the Spleen, ſo the Mucilage is not abſolutely neceſſary to the conſervation of life, ſo the quality of that matter or Juice, which is always found in the *Parenchyma* of the Spleen, does give us ſome reaſon to ſuſpect, that it is deſigned for the generation of this mucilaginous Liquor. For that it contains, and exhibits ſuch a kind of Juice there is no Man, that has his Senſes, and examins it, can deny. And why does it produce ſuch a Liquor, if not for the ſervice, and benefit of thoſe parts, which do ſtand in need of it, and are evidently ſupplied with a Liquor of ſuch a nature as the Juice, which is found in the Spleen is of? Beſides, conſidering of how great, and publick uſe the Mucilage is to moſt parts of the Body, it is not ſtrange, that a *Viſcus* ſhould be formed, and deſigned particularly for the Generation, and Elaboration of it. Moreover from this ſuppoſition, as this Gland has no common Receptacle to entertain, nor proper Ducts to convey the humour, which it ſeparates, to other parts, we may eaſily ſee the reaſon, why it has neither; one was inconvenient, and the other in a manner impoſſible. It was not convenient, that this Liquor ſhould be carried into, and reſerved in any Receptacle in or about the Spleen, becauſe it ſtands at a great diſtance from moſt of the parts, to which the Mucilage is neceſſary, ſo that if it were depoſited in any ſuch large Cavity, it could not be immediately ſupplied upon any occaſions, that are extraordinary, or ſudden, as our motions oftentimes are. And for Ducts it ſeems next to an impoſſibility, that the Spleen ſhould have ſo many, as would be neceſſary to convey the Mucilage to all thoſe parts, which ſtand in need of it; whereas by what I ſuppoſe the thing is done without them, for by the Communication of it to the Maſs of Blood it is brought into a method, in which it is diſpenſable to all the Joynts, the Muſcles, and Tendons, and whatever parts can be thought to require it, ſince the Blood, with which it afterwards Circulates, has its motion through all the parts of the Body, and in its Circulation flows to all the Glands, by which the Mucilage is ſeparated in every part.

I will go farther yet, and now I have endeavoured to prove, that the uſe of the Spleen is to generate this mucilaginous Liquor, I will attempt to explain the manner, how it does it, which was a thought ſuggeſted to me from what I accidentally obſerved, when I was about making one Experiment with the Mucilage. Deſigning to try what alteration an acid-auſtere would make in it, I mixed ſome Spirit of Vitriol with ſome of the Decoction of Galls, and I found, that the mixture produced a ſoft, and perfect Gum. Now as there are evidently gummous parts in the Mucilage, ſo in the Spleen there ſeem to be ſupplied from the Blood two Principles of the ſame nature as thoſe were of, of which I made that Gum, that is an acid and an auſtere to produce it. The Spleen having a ſub-acid taſt, when it is boyled as

Diemerbroek has obſerved, does diſcover an acid in it. I do therefore ſuppoſe, that the Splenick Glandules being formed with two colatory Pores, do by one ſeparate an acid, and by the other an auſtere Juice, which meeting in their ſmall Cavities the one does precipitate the other in the ſame manner as the Spirit of Vitriol did the Decoction of Galls, not into a plain, and perfect Gum, but as the degree both of the acidity, and auſterity is low, only into a more thin Mucilage.

The nature, and uſe of that Liquor, which is naturally ſeparated by the mucilaginous Glands, however it is firſt generated, are ſuch as I have deſcribed. But as other Glands of the Body, ſo theſe do ſometimes, ſeparate, and take off from the Maſs of Blood a morbifick Matter, which becauſe it is not excerned out of the Body, but is thrown, upon, and lodged in ſome parts, which are affected, and injured by it, does excite ſome particular Symptoms, wherever it is depoſited. Therefore all the parts, where any of theſe Glands are ſeated, muſt be obnoxious to Catarrhs, when ever they are diſpoſed for the ſeparation of that Matter, which is Heterogeneous, and Morbifick, and Nature makes an attempt to depurate the Maſs of Blood by them. Now as theſe Glands, as I have ſhewn, are ſeated both between the

Muſcles, and about their Tendons; and in the Interſtices of the Joynts, ſo this defluxion of Matter happens ſometimes to one, ſometimes to the other, and ſometimes to all of them: which when it is excluded from the Maſs of Blood by thoſe mucilaginous Glands, which are ſeated between the muſcular parts, produces a Rheumatiſm; when by thoſe, which ſerve to the Joynts only, and the Tendons, which are inſerted near them, procures the Gout. I ſhall therefore ſay ſomething of both theſe Diſtempers. But before, and in order to the explaining of the Nature, and Cauſe of them I think it neceſſary to give an account of ſome Experiments, which I made with the Mucilage, which is the Liquor naturally ſupplied to, and always entertained in thoſe parts, which are affected in theſe Diſtempers. This I propoſed to my ſelf, that as the humour, which is the cauſe of them, is morbifick, and mingles with the Mucilage, when it is thrown into the ſame Interſtices, ſo the alterations, which I might obſerve from ſeveral mixtures made with the Mucilage, where they agreed with what we often obſerve in theſe caſes, would diſcover both the nature of that humour, which is then the cauſe of theſe Diſtempers, and the reaſon of ſome Symptoms, which accompany them.

The tryals, which I made with this Liquor by mixture, have been many, and more than I ſhall here take notice of, becauſe there were ſeveral, which did not ſucceed ſo as to make any ſenſible alteration in it. The Mucilage which I made uſe of, I had from the Joynts of Oxen, and of a Horſe, which being large Animals, did afford ſufficient quantities for my purpoſe. I made moſt of the tryals both when it was hot, and when it was cold. Vinegar dropt into it, when it was hot, made a conſiderable Coagulation with a *Serum*, to all which I afterwards added the powder of Coral, both becauſe it is eſteemed a Specifick in a Rheumatiſm, and I thought the efferveſcence, which would follow might diſſolve ſome part of the Curd, which the acid had produced, but I found no ſuch effect from it, nor from *Antimonium Diaphoreticum*, Crabs Eyes, nor any thing of a teſtaceous nature, that I tryed. All the following Experiments I made with it, when it was cold: I made the ſame, when it was hot, but becauſe to give a diſtinct account of both of them would be little better than a Tautology, I ſhall only obſerve, that thoſe, which were made with it cold, did produce the ſame effect when it was warmed, to wit, a Coagulation, with Acids, and Stipticks, only in a higher degree; and whereas the Coagulations, which were made, when it was in one ſtate did only change it into a thick Jelly without any *Serum*, after the manner of a Cheeſe, when it it is newly ſet, as they term it, which over the Fire afterwards exhibited two diſtinct parts, a *Coagulum*, and a Whey; in the other, that is, when the Mucilage was hot, the mixtures, which coagulated it, produced a harder Curd, and a *Serum* diſtinct from it. By dropping in ſome of the Decoction of Galls to ſome of it I turned the whole into a gelatinous Maſs, and it was all a ſort of *Coagulum* like a skin, of a whitiſh colour, and ſo tough as to hang all together, when I took it up with a Needle. This *Coagulum*, or Jelly, being laid in the Sun, and dryed, the parts of it ſtuck all together in one piece, but was very friable, and eaſily rubbed to a powder, which was very much like fine flower. The ſame effect had the ſtrong infuſion of *Balauſtia*, Red Roſes, Pomegranate-Pills, and the Peruvian Bark, although there was ſome difference in the Coagulation according to the different degrees of their adſtringency. With a few drops of *Aqua Fortis* diſtilled upon it the Mucilage was immediately coagulated, though the *Coagulum*, which was white, was ſo tender, that it would by agitation be diſſolved in fair water, and make it of the ſame colour almoſt like Milk. Spirit of Nitre made exactly the ſame alteration in it, as *Aqua Fortis* did, a *Coagulum*, which was of a white colour. From which *Phænomenon* I ſhall afterwards endeavour to give the reaſon, why the injuries of the Air, and taking cold are ſo frequently the occaſion of the Gout, and a Rheumatiſm. Vinegar, Spirit of Salt, of Vitriol, Oil of Vitriol, and of Sulphur in ſome Mucilage, which I tryed it with, did not make any conſiderable alteration, when it was cold, but in ſome other it did more, when *Aqua Fortis*, and Spirit of Nitre did produce in all the ſame effects in the ſame degree. And I could not but admire to ſee, that ſo ſtrong an acid as Oil of Vitriol ſhould have no greater effect upon it to alter it, not ſo conſiderable as that of Vinegar, which makes me think, that it is not always the high degree of acidity, that works this change, but there ſeems to be ſomething particular in Wines, which diſpoſes them to coagulate this Liquor, when any of them are made uſe of, and thoſe parts of them, which are apt to act thus upon it, are caſt into thoſe Interſtices, where they have the Mucilage ſingly to work upon. And therefore we find how readily any Wines do procure the *Paroxyſms* of the Gout, where the tone of the Glands is weakned, and the Patient has a diſpoſition to this Diſtemper, which agrees with thoſe tryals, I made with ſome of them. For Claret, White-Wine, and even Sack, but the Claret eſpecially did make a *Coagulum* in the Mucilage like a Jelly. And it was not ſtrange, that Claret, which has both an Acid, and a Stipticity in it, ſhould produce the greateſt Coagulation. A mercurial water made of Sublimate, and *Aqua Calcis* made a very conſiderable whitiſh Coagulation, and rendered it all a thick Jelly, which being held over the Fire turned to a Curd, and a *Serum*. A Solution of *Roman* Vitriol produced a Coagulation likewiſe, ſo did Alum diſſolved in water, but it made a greater alteration in ſome, than it did in others, though the Mucilages were taken from Subjects of the ſame Species. *Saccharum Saturni* did inſpiſſate it, which appeared to be a true Coagulation, becauſe with the Fire they would turn to a diſtinct *Coagulum*, and *Serum*. Salt of Wormwood made no ſenſible alteration, only it ſeemed a little thicker, to which I put ſome of the Decoction of Galls, which immediately produced a Coagulation. Then I dropt in ſome Spirit of Vitriol to ſee what would be the effect of the Colluctation of the Salt, and Spirit, and I found after it was over, that the *Coagulum*, and ſerous part were diſtinguiſhed, and the *Serum* limpid like water. I took ſome of the Decoction of Galls, and added to it Spirit of Vitriol intending to make a ſtrong acid-auſtere, where I obſerved, that theſe two by themſelves produced a Coagulation, and ſtirring of them together, to ſee, if the whole might not be brought to mix by that means, I found the *Coagulum* turned into a viſcous Body, and a perfect ſoft Gum. Then I took out the Gum, and poured ſome Mucilage to the reſiduous Liquor, by which it was changed ſo, as to aſſume a whitiſh colour, but was not conſiderably coagulated, which it was the leſs, becauſe the auſtere parts were moſt of them with ſome of the acid precipitated into the Gum, which I had ſeparated from the ſerous part. But if the Spirit of Vitriol, and the Mucilage are firſt mixt, and the auſtere Liquor be afterwards added, they make a conſiderable, and plentiful *Coagulum*, which will only be broken into ſmaller parts, and not be diſſolved in water. *Aqua Fortis*, and the Decoction of Galls being both dropt into ſome of the Mucilage made a white *Coagulum*, which likewiſe was not diſſolvable in water, although with *Oleum Tartari per deliquium*, and ſo with Spirit of Salt Armoniack dropt upon it, I preſently diſſolved it. I found likewiſe, that the *Coagulum* made with the infuſion of Pomegranate-Pills, Red Roſes, and *Balauſtia*, being mixt with ſome of the Mucilage, to which an acid had been put, made the *Coagulum* more firm, ſo that it would not diſſolve in fair water, but yet the *Oleum Tartari*

tari per deliquium, and the Spirit of Salt Armoniack did the buſineſs in all of them. The *Coagulum* of the Mucilage made with an acid, and the infuſion of the *Peruvian* Bark, and ſeveral other Aſtringents I kept, and dryed, which when they were firſt put to the Teeth ſeemed a little gritty, though after they were moiſt, they were of a ſofter nature: I cannot but take particular notice, that all the mixtures made of the Mucilage with an acid, and an auſtere, produced not only a plentiful Coagulation of a white colour, but ſuch a one as was of a thicker conſiſtence, and not diſſolvable in fair water, as that was, which was made with an acid only, becauſe I ſhall have occaſion to make uſe of this obſervation, when I come to explain the manner, how the *Tophi* are produced in a nodoſe Gout.

And now I come to give an account of ſome ill Offices, which the mucilaginous Glands ſometimes perform to thoſe parts, where they are ſeated, which being, as I ſaid before, either about the Muſcles, or in the Interſtices of the Joynt, do in the one conſpire with other cauſes to procure a Rheumatiſm, and in the other the Gout. And firſt

Of a RHEUMATISM.

I Muſt own, that this Diſtemper having its ſeat in the Muſcular parts, may ſeem to lie out of the compaſs of my Argument, as my Diſcourſe has a reſpect to the Bones, but as I am now concerned with the mucilaginous Glands, it lies ſo in my way, that I ſhould think my ſelf guilty of the neglect of ſome part of my buſineſs, if I ſhould not take this occaſion to offer ſomething concerning it. And what I ſhall ſay of it, is to be underſtood of a true Humoroſe Rheumatiſm: For that, which is Scorbutical, being nervous, and theſe Glands ſeeming to be innocent, and to have no hand in it, my Diſcourſe concerning them does not lead me to conſider it.

That a true Rheumatiſm is cauſed by a flux of humours to the parts affected is univerſally received, and underſtood by Phyſicians, and this Notion agrees not only with the Senſe, which they have of it, but with the Name too, which they have given it, though the manner, in which the morbifick Matter is thrown upon the parts affected, has never been truly explained, nor could it be known without the obſervation of theſe mucilaginous Glands ſeated amongſt them. My buſineſs therefore ſhall be to enquire both what the nature of the Humour is, which cauſes it, and what way it is conveyed to the parts, which it affects, from both which conſidered I ſhall endeavour to account for the Symptoms of this Diſtemper.

The Humour cannot be thought to be the Mucilage it ſelf in its proper, and natural State, for it is too mild and inoffenſive to the tendereſt, and moſt ſenſible Fibres, otherwiſe we ſhould be naturally, and continually afflicted with this Diſtemper in ſome degree or other. Nor can we ſuppoſe, that the Mucilage does at that time, when a Rheumatiſm happens, degenerate in the Blood into any ſuch quality, as makes it acrious, or pungent to the parts, for then all the parts of the Body, that have Glands, which ſeparate the Mucilage, muſt neceſſarily be affected at the ſame time. It is therefore a preternatural, a morbifick Matter diſtinct from the Mucilage lurking firſt in the Maſs of Blood, which being dangerous, and uneaſie to Nature irritates the powers of it to purge the Maſs of Blood from it. But yet it does not ſeem to be the ſame in all Rheumatiſms, but that difference, which may be conceived to be in the Humours, that are capable of exciting ſuch pains, may rationally be ſuppoſed to be in that, which is the cauſe of this Diſtemper, which I therefore judge to be of three ſorts.

Sometimes it is acrious, and more ſubtle, and of ſuch a nature, that though it procures an acute pain, and is almoſt intolerable to the ſenſible Fibres, yet it does not coagulate, nor inſpiſſate the Mucilage, with which it is mixed, when it comes into the Interſtices of the Muſcles, as things of that nature will not do it out of the Body. But becauſe it is hot, and volatile, and ſo not only diſtends the parts by its influx, but diſorders the Spirits, and agitates the Particles of the Blood, which by its quantity, and the compreſſion of the extremities of the Veſſels it obſtructs, there ariſes a heat, and a greater inflammation in the parts, which ſwell. This matter is eaſily, and quickly tranſlated from one part to another, ſo that the ſwellings, eſpecially before the inflammation ariſes, are not ſo permanent, nor the pain ſo firmly fixt in any one part, but wherever it is, it gives the ſenſe of a burning, and fiery quality.

Sometimes the matter is Saline, where though the fixt Salt, as I obſerved of Salt of Wormwood, may a little inſpiſſate the mucilaginous Liquor, yet it does not give it ſuch a conſiſtence, as makes it certainly, and pertinaciouſly fix, though it moves up and down with leſs quickneſs, and the pain does not ſo frequently ſhift its ſeat, as when the matter is acrious, and more ſubtle: beſides which the ſenſe of it is different, as it is pungent, and lancinating.

But then thirdly it is ſometimes, and moſt commonly an Acid, or kind of Corroſive. In which caſe though the matter, whilſt it is in the Maſs of Blood, be not thick, and gelatinous, yet when it comes to be ſeparated from the ſanguineous Maſs, and to be mixt with the Mucilage in thoſe parts, where the Mucilage is depoſited, it coagulates it, and makes it a ſort of a Jelly in the ſame manner, as it will be altered by Spirit of Nitre, and other Acids. And it not only appears from moſt of thoſe Experiments, which I have mentioned, that the mucilaginous Liquor may be thus coagulated in the Body, but in ſome Rheumatical caſes it is evident, that it is ſo. I will not inſiſt upon what may be frequently obſerved from the application of Veſicatories in this Diſtemper, how there appears, when the Bliſter is raiſed, and taken off, under the *Cuticula* a tough Jelly like a thick skin, which I have afterwards diſſolved, becauſe this may not paſs for demonſtration. But I have met with the account of one caſe, which does undeniably prove it; it is in a Colledge of Practice read by Dr. *Drelincourt* at *Leyden*, where he ſays he himſelf in a Perſon, that died of a Rheumatiſm, found a Jelly concreted upon the ſuperficies of the Muſcles of the thickneſs of two or three Ducats. And I had lately the opportunity of obſerving our Chyrurgical caſe, and the account of another from Mr. *Edward Bulkley*, a curious, and obſerving, and skilful Surgeon of this Town, which confirmed me in my opinion. The Patients were both of them his. They had a large Tumour in one of the Thighs, which he, finding a fluctuation of matter, opened by a Cauſtick, and there ran out a large quantity of matter, ſome Ounces of which I ſaw, as it was taken from one of them, and it was not any thing like a *Pus*, but plainly like Milk turned to a Poſſet, conſiſting of ſome pretty large, and many ſmaller pieces of white Curd mixed with a *Serum*, and was lodged in the Interſtices of the Muſcles, where the Mucilage is ſeparated, and depoſited. Now as my obſervation of the mucilaginous Glands about the Muſcles may inform us, what way the morbifick humour was brought thither, and my Hypotheſis does explain the manner, how the matter, which was found, was generated there: So theſe obſervations do ſeem to me clearly to prove, what I would argue for, that the Mucilage is ſometimes coagulated in the Body, whilſt it is animated, eſpecially, when I conſider how exactly it agreed with ſome alterations, I found in the mucilaginous Liquor from ſome mixtures, I made with it, when I had made it hot, When the quality of the morbifick matter is acid, and the Mucilage is coagulated, the pains are more fixt, ſo that, though they ariſe in ſome other parts, yet thoſe, which were the firſt Fruits of the Patients miſery, continue immoved, the pains are corroding, ſo that we have theſe Patients complaining of a gnawing (ſo they are pleaſed to compare it) as if Dogs were tearing of their Fleſh, and this is that Stubborn and Chronical Caſe, which ſometimes perſiſts for half a year, or longer, and it may be is never overcome by all the Art, and Inſtruments of Phyſick. But yet as there is a difference in the nature of the acid, and the degree of acidity, ſo the degree of the Coagulation is ſometimes leſs, and ſometimes greater, and conſequently the Diſtemper is with more, or leſs difficulty vanquiſhed.

It is very probable, that ſometimes there is the addition of an auſtere, which conſpires with the acid to coagulate the Mucilage, and then as the conſiſtence of it is rendered thicker, ſo it is more tough and difficult to be diſſolved, which makes the caſe more Stubborn, and Chronical. However I do not think it is at any time an auſtere only, when the pains are acute.

The way of conveyance, by which this humour, whatever the nature of it is, is derived to the muſcular parts, is by the mucilaginous Glands, and that in the manner of a *Criſis,* ſo that the preternatural Humour, and the Mucilage are caſt into the ſame Receptacles, into the Interſtices of the Muſcles, where they will come to be mixt together, and if the morbifick matter be an Acid, Experiments tell us, that the conſequence will be a Coagulation.

The firſt occaſion of this Diſtemper is known to be generally the taking of Cold, and then it ſeems to be from a nitrous acidity, and ſuch a kind of Spirit in the Air, as deſtroys the due mixture of the parts of the Blood, fixing the Spirits, and thoſe Volatile parts, whoſe motion, and activity do naturally ſo agitate all the reſt, as to confound one with the other, and to preſerve thoſe, which are of the ſame nature, from running together, which is the mixture of the ſanguineous Particles. And when the Air is in an extraordinary degree impregnated with ſuch a Spirit, then is this Diſeaſe more frequent, and Epidemical.

That the Air does conſiſt partly of a Nitre, or nitrous ſpirit is of late an Opinion ſo generally received, and ſo ſtrenuouſly defended, hat he is almoſt thought a Heretick in Philoophy, that denies it. Now that this nitrous pirit may be admitted into the Body even by he Pores of the Skin, I do not ſee how any one can queſtion, who conſiders, how the parts of Mercury, how thoſe of oily Liniments, and Ointments, which are more groſs, will inſinuate themſelves this way. Being therefore received in ſuch a quantity as to precipitate the Blood, and to produce a ſeroſity in it, it Communicates, as coagulating Liquors will do, its own quality eſpecially to the *Serum*, which being thus altered, becomes apt to coagulate the Mucilage, when they meet together in the ſame Cavity. Though I do think, that when any Rheumatick pain ſeizes any part upon the immediate influence of the Air, as when it does affect that place particularly, upon which the cold Air ſtrikes in an unuſual manner, it does more immediately affect the Mucilage, by penetrating through the Pores of the parts into the very Cavities, or Interſtices, where the Mucilage is depoſited: And that ſuch a nitrous ſpirit of the Air will coagulate this Liquor, when it either mingles with it *per ſe*, or Communicates an acidity to the *Serum* of the Blood, and is conveyed to it in that *Vehiculum*, we may be ſenſible from that Experiment, which I made with the Mucilage, and Spirit of Nitre.

The taking of cold, as is evident, does alter the *Craſis* of the Blood ſo, that ſome parts of it loſe their due mixture, and degenerate ſo far as to become unfit ever to be intimately, and amicably mixt with the ſanguineous Maſs again, and thereupon Nature uſes her endeavours to exclude them, that they may neither deſtroy the *Diatheſis* of the Blood, nor continue to diſturb its Circulation. Therefore it is obvious to our Obſervation, that there follows either a Fever, which is only an attempt to overcome, and exclude that Heterogeneous Matter; which endeavour is more ſenſible and protracted, becauſe the matter is not excluded by any Glands, which perhaps may therefore be retained in the Blood, becauſe the Particles of it are not yet accommodated to the Pores of any Glandules, and as the violent commotion in the Maſs of Blood at that time is in order to expel them, ſo we may ſuppoſe it is no leſs to break, and ſo figurate them, that they may be capable of being excerned by ſome Glands, which when it is once done, there follows a *Criſis*. I ſay there follows either ſuch a Fever, or ſome Evacuation. Sometimes Nature is ſo intent upon this affair, and ſo violent in her attempts to throw off this matter, as to ſuſtain the loſs of her own Treaſure, and the purer parts of the Blood in the excluſion of thoſe, which are Incongruous, and Morbifick, as when the *Criſis* is made, or endeavoured by a Hemorrhage: but commonly this is done without that expence, and then it is by the glandular

Sluices, but not always by the ſame, ſometimes by thoſe of one ſort, and ſometimes by thoſe of another, according as they are diſpoſed to receive, and ſeparate the morbifick Particles. Therefore upon a Cold we have ſometimes a *Criſis* by the Glands of the Noſe, as in a *Coryza*; or by the ſalivatory Glands; at another time by them of the *Trachea*, and *Bronchia*, as in a Cough, or Catarrh upon thoſe parts; ſometimes by the cutaneous Glands, and ſweating; ſometimes by thoſe of the Inteſtines, and a *Diarrhœa*. Neither are the mucilaginous Glands always excuſed; but the Maſs of Blood exonerates it ſelf by them, by which the morbifick humour being ſeparated it is neceſſarily caſt upon the Muſcles and Tendons, where the nitrous Spirit, Communicated from the Air, and the matter depraved by it coming to act upon the Mucilage ſingly doe inſpiſſate it, and produce that Diſtemper, which we call a Rheumatiſm.

Although this Diſtemper does often owe its Original to the preception of Cold, yet it is ſometimes contracted from other cauſes, and occaſioned from the liberal drinking of Rheniſh-Wine, and thoſe Liquors, which are in the ſame manner acid. Neirher have we any reaſon to wonder at it, when we conſider the nature of the Blood, and the Chyle, which does daily feed the Veſſels, and repairs the ſanguineous Maſs. I need not go about to prove, that the Chyle is of the nature of Milk, ſince the Opinion has generally prevailed, that Milk is the very Chyle conveyed to the Breaſts, either by the Arteries, before it is aſſimilated to the Blood; or by more immediate Ducts. And Experiments do tell us, that they both undergo the ſame alteration from the mixture of an Acid. What muſt we then think of the Blood, which is every day renewed, and maintained by it, but that it borders upon the nature of it? So that ſince ſour Liquors do produce a ſeroſity, and a Coagulation in one, we muſt expect it will make an alteration in the Blood, which is ſomewhat like it, though not in the ſame degree, eſpecially if we drink plentifully of Liquors, that have much of an acidity in them, whilſt the Chyle retains its lacteal nature, and before it is aſſimilated to the Blood. And I knew one, in whoſe cure I was concerned, who was Scorbutical, that upon the drinking of ſharp Wines, ſuch as White-Wine, and Rheniſh, eſpecially at that time, when ſome of the Chyle was yet in the lacteal Veſſels, and whilſt that, which was newly ſupplied to the Blood-Veſſels, was milky, would find the ſame effect, as from the injuries of the Air, to wit, plainly a Cold, for ſo I muſt call it, in his

Head, and a *Coryza.* And when we find theſe Wines ſo Diuretick, it argues ſomething like a Coagulation, which cauſes many of the ſerous parts to loſe their mixture, and diſpoſes them to a ſeparation.

When theſe parts are ſo altered, and once deprived of their due mixture, as they are never again, or not eaſily to be reduced to their natural ſtate, nor in that, which they are in, conſiſtent with the good *Craſis*, and regular motion of the Blood, they become a peccant, and an offenſive humour. So that the buſineſs of Nature then is, as in a Cold, to extrude them from the ſanguineous Maſs. And what is that plentiful excretion of Urine, which commonly attends, or follows the liberal drinking of ſuch Liquors, but a kind of critical Evacuation of *Serum*, or a depuration of the Maſs of Blood from ſome parts of it, which, when they are precipitated, and have loſt their due mixture, agree better with a Chamber-pot than the ſanguiferous Veſſels.

As the ſerous parts altered by the nitrous Spirit of the Air, ſo neither the acid Liquors, which we drink, nor the *Serum* precipitated by them, are always ſeparated by the ſame Glands. Though this ſeparation is often by the Kidneys, yet ſometimes it is made by thoſe, which ſupply the *Saliva*, eſpecially in ſome

Scorbutical Perſons, which I have often obſerved; ſometimes theſe Liquors not only increaſe a Cough, and heighten the Symptoms of it, which experience tells us will be the effect of our ordinary drink, but they ſometimes produce a Catarrh upon the Lungs; and ſometimes it ſo happens, that the morbifick Matter is thrown upon the mucilaginous Glands, which having the convenience of exonerating themſelves, caſt it off into the Interſtices of the Muſcles, and Tendons. Being depoſited in the Receptacles, if I may ſo call them, of the Mucilage, it mixes with it, and as we ſee that the Acid, which produces a *Coagulum*, and a *Serum* in any Liquor, Communicates its own quality more eſpecially to the *Serum*, ſo theſe Wines, which cauſe a kind of Coagulation in the Blood or Chyle, will impregnate thoſe ſerous parts, whoſe due mixture they deſtroy, with an acid quality, and render them of ſuch a nature, as that they will coagulate the Mucilage, when they come to mingle with it, as I have ſhewn that theſe Wines themſelves will do it.

Although the humour thus ſeparated does produce a new Diſtemper, it is no more improper to call it a *Criſis*, than Buboes, and the ſwellings of the *Parotides* in Peſtilential Fevers. For though it be not ſo in reſpect to the whole Body, yet in reſpect to the Maſs of Blood it is. And I have obſerved, where a Rheumatiſm has been evidently critical, as particularly in one Patient I had, who laboured with a Fever, in the Declenſion of which there came on a Rheumatiſm in her Arms, which without doubt, was one thing, that ſolved it, as Nature excluded from the Maſs of Blood part of that Matter, which before had diſordered it, by the mucilaginous Glands of thoſe parts.

The Symptoms of this Diſtemper may be eaſily, and fairly accounted for from the nature of the Matter, and the cauſes of it, as I have explained them, and the manner, in which I have ſuppoſed it is produced. They are generally a ſwelling of the parts affected, ſometimes with a redneſs; ſevere and acute pains, there is commonly a Fever, a rigidity in the parts, and ſometimes in the declenſion a Stupor, and Stifneſs.

For the firſt the Tumours, they muſt neceſſarily attend this Diſeaſe, if it be cauſed in that manner, in which I have endeavoured to prove it is. For when the morbifick Matter is plentifully ſeparated by the mucilaginous Glands of the Muſcles, and caſt into the Interſtices, it cannot but diſtend, and raiſe thoſe parts, which lie above it. And beſides what is lodged in thoſe Cavities between the Muſcles, the Catarrh, or vaſt influx of the Humour will in an extraordinary manner fill, and diſtend the Glands themſelves, and ſo far increaſe the thickneſs of the *Membrana communis Muſculorum* as to cauſe a ſenſible elevation of the parts, which lie over it. Thus we ſee the Glands on the inſide of the Noſe in a *Coryza* are ſometimes ſo diſtended, the Membrane of the Noſtrils ſo tumified, that the paſſages are ſtopt, and we are obliged to find another way for the inſpiration, and expiration of the Air. And ſuch a ſwelling, and thickneſs I obſerved in thoſe parts of the common Membrane of the Muſcles, which I found Hydropical.

With the influx, and plenitude of the morbifick Matter conſpires that, which follows upon it, an obſtruction in the Blood-Veſſels. This is evident, that a ſmall compreſſion upon the Veſſels, where they are minute, will force one ſide of them to be contiguous to the other, and where the compreſſion is great, as it muſt be where there is ſuch a preternatural fulneſs, and ſwelling of the adjacent parts, we may well ſuppoſe the Veſſels to be ſo obſtructed, that the Blood can at beſt but with difficulty Circulate through them: ſo that the continual appulſe of it flowing more plentifully and freely into them, than it can proceed into the Veins, will ſwell and diſtend the

Veſſels, in which it is obſtructed, as we ſee the Veins will be tumified below a Ligature, and in an *Ophthalmia* we find the obſtruction of the Blood will ſo inlarge the Veſſels as to make them appear viſible, which were before indiſcernable.

The reaſon of the pains we may be able eaſily to underſtand from the Nature, which I ſuppoſe the morbifick Matter to be of. When it is either Saline and pungent, acrious and urent, or acid and akin to a Corroſive, it is ſufficient to excite ſuch pains, and we can expect no better treatment from it, when it falls upon ſuch ſenſible parts as the Muſcles, and Tendons, and the *Membrana communis Muſculorum.* Beſides the ſenſe, which ariſes merely from the quality of the Matter, the copious influx of it into the parts affected, ſtretching the Fibres beyond their natural tone, does affect them with a dolorifick ſenſe, at leaſt by making them tenſe it renders them more ſenſible of the pain excited by the Salt, the acidity or acrimony of the humour, which is more intenſe or moderate as the quantity of the matter, and the degree of its quality are greater or leſs.

The Fever, which is another Symptom, that commonly attends this Diſtemper, does firſt ariſe from the Heterogeneous nature of the morbifick Particles, and their unfitneſs to be mixt with the Maſs of Blood, at which time it is moſtly an effort of Nature to expel them, but afterwards it is continued by the acuteneſs, and ſeverity of the pains exagitating the Spirits, and producing a diſorder and a tumultuous violence in their motion, which they Communicate to the Blood as they have a continual influx into it, to invigorate it, to promote its Circulation, and to preſerve the mixture of its parts. And to this Fever ſomething may be added from the compreſſion, and obſtruction of the Blood-Veſſels. For when the free Circulation of the Blood is hindered in one part, it ſeems obliged to move quicker in others: As we ſee in a River dividing it ſelf into two Channels, if one of them be ſtopped up, the motion of the Water will be more rapid in the other.

Beſides the rigidity, which neceſſarily follows the ſwelling, and preternatural fulneſs of the parts, there is both a Stifneſs, and Stupor, which the Patient has commonly the ſenſe of after the Rheumatick pains are in a manner gone off. Both of them I conceive to be from an alteration in the nature, and conſiſtence of the Mucilage, and the effects particularly of ſuch a Rheumatiſm, as is cauſed by an Acid: To preſerve the Fibres flexible and tenſile it is neceſſary, that they be lubricated, and moiſtened; and for the continual motion, and influx of the Spirits into them, it is requiſite not only, that they be ſupplied in a ſufficient quantity, but their paſſages the *Canaliculi* in the Nerves, and fibrous parts muſt be clear too. Now when the Mucilage is coagulated, it becomes unfit to lubricate the Muſcles, and Tendons, or to moiſten, and preſerve their Fibres ſo pliable and tenſile as naturally they were. Whereupon they cannot be ſo eaſily contracted, nor thoſe parts of them, which approach nearer to their Origination, when they act, ſlide ſo readily, as they ought to do. And there may be ſome oppoſition in the Tendons of the Antagoniſt Muſcles to their own extenſion, as they muſt be extended when the others are contracted. I did not long agone in the tendinous Fibres of a Horſe obſerve tranſverſe, and circular wrinkles or Corrugations, which if we ſuppoſe to be in our own Tendons, and muſcular Fibres, when they are not extended, which we have great reaſon to do, then we may reaſonably think that the coagulated Mucilage inſinuating it ſeſt into, and ſticking in the ſmall *Foveæ*, or Furrows, hinders the free and eaſie extenſion of thoſe parts.

So the Stupor or numbneſs, which ſometimes affects the parts after a Rheumatiſm, proceeds from the ſame alteration in the conſiſtence of the Mucilage. For although the obſtruction, and defect of the Spirits be the immediate cauſe, yet this obſtruction ariſes from ſuch an alteration in the Nature of that Liquor, as renders it unfit to perform its office, and to moiſten the nervous Fibres, for want of which they will become more dry, than they ought to be, and conſequently their ſmall Pipes will be contracted. So that this Diſtemper, where there has been ſuch a Coagulation, leaving ſometimes ſuch an alteration in their temper, as contracts, and ſtreightens their *Canaliculi*, or ſmall Cavities, impedes the plentiful influx of the Spirits into them, and their courſe through them. And where we have ſuch a Stupor, I am apt to think, there remains ſome part of the inſpiſſated Mucilage after the pains are ceaſed, and when the ſwelling in a manner diſappears, and that it is thicker, than it is during the height of the Diſtemper, though becauſe it has loſt that quality, which made it dolorifick, it does not affect the Fibres in the ſame manner, as it did before. This anguſtation of the *Canaliculi* of the Fibres, if it proceeds to a total obſtruction, produces a Palſie, as ſometimes we do obſerve, that this Diſtemper ſucceeds to a Rheumatiſm.

From what I have ſaid concerning the matter, which is often the cauſe of this Diſtemper, how it is an Acid, and coagulates the Mucilage, we may underſtand the reaſon, why a Rheumatiſm continues ſometimes ſo long, and ſtubborn. And when it is ſo protracted, I take this to be a true Diagnoſtick of the nature of the morbifick Humour.

If I may have leave here to make a little incurſion into the Phyſicians Province, I would add ſomething concerning the Cure. And from what I have ſaid of the diverſity of the Humours, which may be the cauſe of a Rheumatiſm, we may diſcover ſome reaſon for altering the means, and method of Cure at ſome times. And as the difference of the Humour does indicate the uſe of different Medicines, and ſhews the unreaſonableneſs of one common and conſtant method in all even true, and humoroſe Rheumatiſms, ſo by attending to the ſigns, which diſcover the quality of the Humour, and whether it has coagulated the Mucilage or not, we may be directed both in our Prognoſticks, and the choice of Means.

This I may lay down as a general Rule, that ſince a Rheumatiſm, as I have ſhewn, is a *Criſis*, or depuration of the Blood by the mucilaginous Glands, we muſt endeavour to put Nature into another method, and to procure the excluſion of the matter by ſome other

Glands, which may free not only the Maſs of Blood, but the whole Body from it; where it is to be conſidered, what excretory Glands do ſeem moſt apt to ſeparate, and carry off that morbifick Matter, which is to be excerned. For as there is ſometimes a difference in the nature of the matter, ſo every ſort without doubt will paſs off more readily by one particular way of Evacuation, than by any other.

When the morbifick Humour is acrious, and of ſuch a nature that it does not upon its mixture coagulate nor inſpiſſate the Mucilage, the moſt convenient Evacuation after bleeding ſeems to be by the cutaneous Glands, and however Diaphoretick Medicines may *malè audire* before the declenſion of a Rheumatiſm, yet in this caſe they may be certainly uſed not only with ſafety, but with benefit provided they are temperate, and free from an acrimony, ſuch as *Pulvis é Chel. compoſitus*, *Lapis Contrayervæ*, *Antimonium Diaphoreticum*, a Decoction of *Sarſa*, and things of the like nature.

Beſides Evacuation, there muſt be an endeavour to temper the heat, and to correct the Acrimony, in order whereunto ſome ſorts of Emulſions will be convenient, and this is the caſe, in which the Tincture of Roſes, which is uſed without any diſtinction in humoroſe Rheumatiſms, is truly a Specifick. For where the humour is acid, and the Mucilage coagulated the uſe of it does ſeem neither reconcileable to Reaſon, nor to be defended againſt, what Experiments dictate to us. Our Reaſon will tell us, that aſtringents as Red Roſes, are not proper to attenuate, nor an acid as Oil of Sulphur, or of Vitriol to prevent or diſſolve a *Coagulum.* By Experiments we ſhall find, as I have already ſhewn, that both Roſes, and Oil of Sulphur, or Oil of Vitriol, with which this Tincture is made, do produce the ſame alteration in the Mucilage, that the morbifick Matter in this caſe does induce, ſo that they cannot be proper means to Cure it, nor effectual Remedies to prevent the farther degrees of the inſpiſſation.

Where the humour is *Saline*, or Briny, though I will not wholly condemn Diaphoreticks, becauſe ſuch a humour ſeems in ſome meaſure apt to be excerned by the cutaneous Glands, as the ſweat is naturally ſalt, yet the moſt convenient way of Evacuation is by a *Diureſis* : So that as I propoſed Diaphoreticks in the firſt caſe, ſo I conceive Diureticks to be moſt proper in this. For tempering the fixt Salt it ſeems reaſonable and neceſſary to dilute it, and in order to correct it we may allow ſuch light acids as will alter the nature of it in the Blood, and not coagulate the Mucilage, if they proceed ſo far as to change the nature of that ſalt humour, which is lodged in the Interſtices of the Muſcles. So that here it is, where the Conſerve of *Fructus Cynosbati* ſeems to be a Specifick. And in this caſe I do not ſee, why we may not both with ſafety, and benefit make uſe of ſtronger Acids, ſeeing the fixt Salt, and the Acid will mutually alter, and correct each other, that the latter may not have a power to coagulate the Mucilage, if it ſhould not only act upon the morbifick Matter in the Maſs of Blood, but alſo find a way into the Interſtices of the Muſcles by the mucilaginous Glands. What Coral, which is propoſed as a Specifick in all humoroſe Rheumatiſms without ſuch a diſtinction, as I have made, is like to do in this caſe I do not well apprehend.

The third and laſt ſort of Humour, which I ſuppoſe to be moſt frequently the cauſe of a Rheumatiſm is an Acid, ſuch as not only diſtends the parts, where it is depoſited, and affects them with a pain, but likewiſe makes a conſiderable alteration in the conſiſtence of the Mucilage. When the Mucilage is thus coagulated Diaphoretick Medicines are certainly pernicious, not only in the augment, and height, but through the whole courſe of the Diſtemper, unleſs it can be firſt ſo attenuated, as to be capable of being diſcharged out of thoſe Cavities, in which it is lodged, and the ordinary method of Practice, which forbids the uſe of them till the declenſion of it, is in this caſe highly reaſonable. Though I ſay, they are at no time proper, unleſs the inſpiſſated matter be firſt diſſolved, and attenuated, as a preparatory to the uſe of ſuch Medicines. However, the effects I found from Spirit of Salt Armoniack poured upon the coagulated Mucilage, and its contrariety to an Acid may lead us to the plentiful uſe of ſuch a Diaphoretick as that is, and of all thoſe things, which do in the ſame manner diſſolve a *Coagulum*. When the matter is thick, and gelatinous, what can other Diaphoretick Medicines do? Suppoſe they raiſe a ſweat, and drive out ſome parts of the matter, which lies beyond the mucilaginous Glands, we muſt expect they will be thoſe, which are the moiſt, and thin, which are neceſſary to prevent its induration, and to conſpire with our endeavours to attenuate it, by which means we have the coagulated Mucilage reduced to a thicker conſiſtence, and rendered more uncapable of being diſſipated, and conſequently the cure of the Diſtemper more tedious, and difficult. And as I ſuppoſe the more than ordinary toughneſs, and the very thick conſiſtence of ſome part of the coagulated Matter remaining after the pains are gone off, does cauſe ſome Symptoms, ſo I am apt to think that an imprudent uſe of Diaphoreticks may reduce the matter to that thickneſs, and be the cauſe of that rigidity, and Stupor, which are ſometimes left behind. There is one thing, which may deſervedly be recommended, where the morbifick Humour has coagulated the Mucilage, that is Salt of Tartar, the nature of which we know to be ſuch as will correct an acid, and if Experiments may not be thought to deceive us, will be no leſs effectual to diſſolve the coagulated Mucilage, as appears from, the tryals I made with it, which I have given an account of. Here Coral, and teſtaceous powders may be thought to be proper, and ſpecificks. For, though it is true, they will not diſſolve the *Coagulum*; yet by correcting the Acid in the part affected they will mitigate the pains, and by altering that part of the morbifick Matter, which is not yet excluded from the Maſs of Blood, they will cut off that ſupply, which would feed, if I may ſo ſpeak, and protract the Diſeaſe. Some Phyſicians for the ſecurity of the reſpiratory Organs do in the Cure of Rheumatiſms preſcribe mucilaginous, and oily Pectorals, which in this ſort of Rheumatiſm do ſeem highly reaſonable in reſpect not only to the Lungs, but likewiſe to thoſe muſcular parts, which are affected. For they ſtanding in need of, and having naturally the ſupply, and benefit of an Oil, and a mucilaginous Liquor, and the nature of the Mucilage being ſo altered, as to be uncapable of anſwering its intention, this is imitating Natures Compoſition, and ſubſtituting an artificial mixture, which ſupplies the defect of that, which the morbifick Matter has vitiated.

To this kind of Rheumatiſm there are ſome Evacuations, which ſeem more peculiarly agreeable, than any others. By obſerving the tendency of the Matter to the Salivatory Glands, and the plentiful ſpitting, which ſome Patients have in this caſe, I am inclined to think, that a Salivation may here be very proper. And the tough, and gelatinous Matter, which I have ſeen gathered under the *Cuticula* from the application of Veſicatories to the parts affected, I may ſay the ſenſible relief, which I have known from them has been an Argument to perſuade me, that the *Cantharides* are in an eſpecial manner effectual to Evacuate the coagulated Matter.

Of the GOUT.

I Proceed now to conſider the other Diſtemper the Gout. And if I ſhould be thought to have made a Digreſſion in what I have ſaid of a Rheumatiſm, I return now to my Argument. For this Diſeaſe, as it has its ſeat amongſt the Bones, does plainly lie within the compaſs of it.

A great part of that account, which I have given of a Rheumatiſm, is applicable to this, the humour, which excites the pains is of the ſame nature, the Glands, by which it is ſeparated from the Maſs of Blood, of the ſame kind, the parts, upon which it is caſt, equally ſenſible, and ſome of them, as the Tendons, which are inſerted near the Joynts affected, *in Specie* the ſame: but the ſeat of it is different, which being in the Joynts, and about the Tendons, that lie near them, changes the name of a Rheumatiſm, which may be taken for a more general one, for the particular denomination of an *Arthritis* or Gout. However, ſince it has a relation to our Bones, and the Argument I am concerned with, does direct me to a particular conſideration of it, I ſhall ſay ſomething firſt of the nature of the Matter, which cauſes it: Secondly, I ſhall explain the manner, in which, and the reaſon, why it is carried to, and lodged in the parts affected. Thirdly, I will endeavour to give the reaſon of the Symptoms. In all which I ſhall as much, as ever I can, avoid the repetition of any thing, that I have ſaid of the firſt Diſtemper.

For the firſt the nature of the Humour, I conceive, that there is the ſame difference, which I ſuppoſed in a Rheumatiſm, that it is ſometimes Saline, and pungent; ſometimes acrious, and urent; and moſt frequently an Acid or in a manner corroſive. I have this to add, that it is certain, it is not always of the ſame nature from the different, and ſomtimes contrary effects of the ſame remedies, which we find to be ſo uncertain, and fallacious, that we commonly doubt of the ſucceſs of one thing in one Patient, which we have found to be efficacious, and beneficial to another.

Though there be theſe differences at ſome times in the morbifick Matter, yet very commonly the humour ſeems to be an Acid, and I conclude it to be very often ſo not only from what we may obſerve in many Patients about the time, when the fit is coming, and whilſt it is upon them, as we ſhall have them complaining of ſour belchings, and throwing up acid humours by vomit: but alſo from the procataretick cauſes, which frequently give the Patient the firſt diſpoſition to this Diſtemper, and afterwards procure the *Paroxyſmes* of it, when he adventures to make an Experiment of their effects: theſe are ſuch Liquors, as have much of an acid in them, and do eaſily degenerate, and turn into a ſharp Vinegar, as *French* Wines, Cider, and the like.

The manner, in which the morbifick humour is caſt out from the Maſs of Blood, when it is thrown into the Interſtices of the Joynts, and upon the Tendons, which lie near them, is by the way of a *Criſis*. And this makes the Diſtemper return by *Paroxyſmes*, which when the Maſs of Blood is depurated, and the morbifick Matter, which Nature had depoſited about the parts affected, is diſſipated and ſpent, go off. But when the Blood comes by degrees, or from ſome great occaſion more ſuddenly to be again impregnated with ſuch a quantity of theſe heterogeneous Particles, that the whole Maſs is in danger of being depraved, and Nature is irritated to endeavour their excluſion, then they return; there will follow ſome diſcharge by thoſe Glands, which are moſt apt to receive and ſeparate them, which in this Diſtemper being thoſe, that ſupply the Mucilage to the Joynts, the morbifick Particles are caſt upon theſe parts, where they raiſe ſuch Symptoms as are the genuine effects of their own nature, and ſuch as the parts in which they are depoſited, are thereupon ſubject to.

That the morbifick Humour is in this manner, that is critically thrown upon the affected parts, we have reaſon to conclude from that *Febricula,* which immediately precedes the *Paroxyſmes* of the Gout, and ſhews, that Nature is then diſturbed, and making an attack upon the hoſtile Matter. And, as when the *Criſis* of an ordinary Fever is once begun, and proceeds by a Sweat, if the ſweat be ſuppreſt, that that *Criſis* is hindered, and no other ſucceeds to it, the Fever is increaſed, and all the Symptoms of it often renewed by the retention of the *febrile* Matter in the Maſs of Blood: In the ſame manner will the interterruption of this *Criſis* by the mucilaginous Glands of the Joynts, or the reflux of the Matter into the Blood occaſion a Fever, if Nature does not find ſome other way to depurate the ſanguineous Maſs: as *Foreſtus* in the 21. Obſervation of his 29. Book, tells us of one, who laboured with the *Sciatica,* and upon making a Ligature to open a Vein in his Foot he fell into a Swoon, ſo that they could not bleed him, however he was cured of his pain, but fell into a Fever.

Upon this ſuppoſition, that every fit of the Gout is from a critical excluſion of morbifick Particles from the Maſs of Blood, and their ſeparation by the mucilaginous Glands, we may apprehend, how the *Paroxyſmes* of it may be, as they are commonly eſteemed, a preſervation of the Patient's Life, and a ſecurity againſt violent Fevers and any other more fatal Diſtempers, as they depurate the Maſs of Blood from thoſe *Feculencies,* which if Nature had not this ready, and eaſie way to caſt them out of the ſanguineous Maſs, would produce ſuch a diſorder, and excite ſuch a violent fermentation, as makes a Fever. Upon which fermentation if the morbifick Matter happens to be determined to, and thrown upon the Glandules of the more noble parts, then muſt the conſequence be ill, if not fatal, ſuch as an Apoplexy, a *Phthiſis,* an *Aſthma,* or the like. If the Maſs of Blood can never be ſo victorious, as to exclude them by ſome Glands, there muſt neceſſarily follow a *Cachexy* or ill habit of the whole Body, and all the miſchiefs, that attend it. And when does this Diſtemper prove fatal, but when the Matter is tranſlated to, and fixed upon ſome noble Part, or Nature is tired, and ſo languid, that ſhe cannot riſe up againſt her Enemy with ſo much vigour, as to drive it to the extreme parts. Neither do the arthritick *Paroxyſmes* only give the Patient ſome ſecurity againſt other Diſtempers, that might proceed from thoſe impurities, which the Blood inſenſibly contracts, but as the mucilaginous Glands of the Joynts, are diſpoſed and ready to take off any incongruous Matter, as the Blood has occaſion to make uſe of them, they often prevent thoſe Diſeaſes, which would otherwiſe ariſe from evident occaſions.

The ſecretory Organs, which ſerve to this *Criſis*, and ſeparate the morbifick Humour, that cauſes the *Paroxyſmes* of the Gout, are *in Specie* the ſame as thoſe, by which the Matter in a Rheumatiſm flows to the parts affected, that is the mucilaginous Glands, and I have ſaid ſo much of them of the Articulations, and Tendons, that it is eaſie to prove, they are parts, which by reaſon of theſe Glands are evidently obnoxious to the afflux of a preternatural Humour.

Although the morbifick Matter is ſometimes obtruded upon, and ſeparated by the mucilaginous Glands of ſome one particular part, yet it is not very ſtrange that the Symptoms will often ſhift their ſeat, and that ſometimes very ſuddenly. For though Nature will bear ſome leſſer quantity of heterogeneous Particles, and they may lurk in the Maſs of Blood for ſome time, when they have a ſmall beginning, and increaſe inſenſibly, yet when they come to that fulneſs, that the whole Maſs is in danger of being vitiated, and Nature is irritated to expel them, there ariſes a fermentation in the Blood in order to exclude them, which being once begun is not eaſily ſuppreſt, but if the *Criſis* by the Glands of the Joynt, where it is firſt attempted, and begins, be interrupted, then there is a recourſe to ſome other Glands either of the ſame kind, as when the Matter is tranſlated from one Joynt to another, or to ſome other mucilaginous Glands; or of a different ſort, as when the morbifick Matter is thrown upon the Lungs, the Brain, or Stomach. And how frequent is this motion of the Peccant Humours from ſome Glands to others in other Caſes? How common, is it for Nature in the Evacuation of any morbifick Matter, when ſhe cannot finiſh her work by the Glands of one part, to command the ſervice of others? Thus ſometimes we ſhall have a *Diarrhæa* ſucceed to the ſtopping of ſweats, and the ſuppreſſion of a *Diarrhæa* excite a kind of Salivation. In the Small Pox, if the *Puſtules* fall, and the ſpitting of the Patient unexpectedly ſtops, how often, and how ſuddenly does Nature endeavour an excretion of the morbifick Matter by the Glands of the Inteſtines, and ſometimes the Kidneys are obſerved to undertake the work of the cutaneous, and ſalivatory Glands, when the excretion of the variolous Matter does not proceed well by them.

I take notice of this *Phænomenon*, and have explained the reaſon of it, to ſhew that the quick motion of the arthritick pains at ſome times, and the ſudden tranſlation of the Humour do not make it neceſſary to ſuppoſe, that the morbifick Matter, or any part of it is immediately ſupplied from the Nerves, as ſome would have it to be. Neither do I ſee how the *Metaſtaſis* of the Matter does in the leaſt favour ſuch a ſuppoſition, unleſs it could be proved that the paſſage and tranſlation of it is more free, and eaſie by the Nerves, than by the Blood-Veſſels. And to make it farther evident, that this obſervation does not make it improbable, that the Matter is derived from the Maſs of Blood in the Gout, let us conſider how patallel the caſe lies between an *Arthritis*, and an *Eryſipelas* in this reſpect, where the Matter is generally allowed on all hands to be from the Blood. Does the arthritick humour, when it is repelled, or by any occaſion ſuddenly removed from the part affected, appear with its Symptoms in ſome other, ſometimes ſhewing it ſelf in another Joynt, ſometimes revenging the diſturbance upon the more Noble Parts? So in the *Eryſipelas* we ſometimes obſerve a tranſlation of the matter as quick and ſudden, as that in the Gout, and in the ſame manner it ſometimes ſhews it ſelf again by Glandules of the ſame nature in ſome external part, ſometimes it is caſt upon the Brain, the Stomach, or the Lungs. But yet the arthritick pains are often fixt, and immoveable, and when the matter ſo ſuddenly ſhifts its ſeat I take it to be either acrious, or ſaline, rather than an acid.

From this ſuppoſition, that the morbifick Humour is ſeparated by the mucilaginous Glands of the Joynts, and the Tendons which lie near them, we may eaſily ſatisfie our ſelves, why the Gout does invade thoſe parts, which we find to be obnoxious to it. As for the Sciatica, or Hip-Gout, I have taken notice, that the mucilaginous Gland of the *Acetabulum* of the *Coxendix* is one of the largeſt of the ſort in the whole Body, ſo that it is no wonder, that the Humour is excerned, and thrown into the Cavity by it, and excites ſuch Symptoms as we find there. In the Hands, as I have ſhewn, there not only are conſiderable Glands in all their Joynts, but the Tendons, which are there inſerted, eſpecially thoſe of the *Muſculi Perforantes* have their mucilaginous Glands, ſo that Nature has a convenience in theſe parts to depurate the Maſs of Blood, and they muſt receive the morbifick Matter, when the Blood in its

Circulation obtrudes it upon them, and the Glands are diſpoſed to ſeparate it. The ſame thing I might obſerve of the Shoulder, and of the Knees. But of all the parts none are ſo frequently afflicted with this Diſeaſe, as the Feet, and it is plain, why they are ſo. For beſides that they have many mucilaginous Glands in their Joynts, and others about the Tendons, which are inſerted into their Bones, as the great Chord, or Tendon of the Muſcles, which extend the Foot, and thoſe of the *Perforantes*, I ſay beſides this, they are the infeferior, and pendulous parts, ſo that as their Glands make them capable of entertaining, ſo their ſituation does conſpire with the effort of Nature to bring down the morbifick Matter into them.

I ſhould in the next place conſider the reaſon of the Symptoms, which are an acute Pain, a Tumour, which does moſt commonly, but not conſtantly attend the Gout, and the *Tophi*, which are ſometimes generated in this Diſtemper. In the ſwellings there is nothing ſo particular, and different from them in a Rheumatiſm, that I need add any thing to what I ſaid concerning them of a Rheumatiſm. So the ſenſe, and Symptom of pain being always found in that Diſtemper, I have been already obliged to take notice of it, and what I have ſaid concerning it, when it accompanies a Rheumatiſm, may diſcover the reaſon of it here from the nature of the Matter, and ſo far as it affects the Tendons. But there is one thing here, which deſerves our conſideration, that is how the Joynts themſelves, or what parts of them are affected with the pain. I have ſuppoſed the Bones themſelves to have ſome ſenſe by the mediation of of thoſe Fibres, which from the *Perioſteum* penetrate, and are inſerted into their ſubſtance; but yet ſince the extremity of an articulated Bone has no Membrane, I cannot tell how we ſhall make this part of them capable of Communicating that impreſſion to the ſenſitive Faculty, which the quality of the morbifick Matter is apt to make upon it. There are therefore only the Ligaments, and the Membrane, which lies immediately over the Articulations, with the mucilaginous Glands, that can there be the ſubjects of it. This, as other Membranes are found to be, may reaſonably be thought to be acutely ſenſible. And if I ſhould ſay, the Ligaments themſelves have ſome ſenſe, I do not think I ſhould ſpeak either abſurdly, or erroneouſly. I know it is a common opinion, that they have none, as being a thing inconſiſtent with the convenience, and wel-being of an Animal, and that, which would entail an uneaſineſs, and pain upon the motions of it. But ſuppoſing they were ſenſible, I do not ſee any neceſſity to conclude, that their motion, and the ſtreſs, which is at any time put upon them, would be uneaſie, and troubleſom, ſo long as that place of the Bone, upon which any part of the Ligament ſlides, is poliſhed, and continually lubricated with a ſoft mucilaginous, and oily ſubſtance, and ſo long as there is no violence offered to them, and they are not extended ſo as to exceed their bounds preſcribed by Nature. Is it not as ſtrange, that the Stomach, which all muſt acknowledg to be ſenſible, does daily receive the Nouriſhment, takes in ſome matter, that is actually hot, as well as ſome, that is cold, and by that matter is diſtended; yet feels not the ingreſs of the Food into its Cavity, perceives not the extenſion of its Fibres, unleſs there be ſomething offenſive in the quality, or ſome exceſs in the quantity of what we eat or drink. The reaſon of which ſeems to be very much the continual uſing, and accuſtoming of Nature to the thing. So in the Ligaments beſides the ſmoothneſs, and lubrication of that part of the Bone, which they move upon, their being always contiguous to it, and accuſtomed to ſlip upon it, makes them unconcerned, and is the reaſon, why they perceive no diſorder in their Spirits, though they have a ſenſibility. And it is evident, that the contiguity of a ſenſible part to that ſofter ſubſtance of the articulated Bones, which is at their extremities, is conſiſtent with the eaſe of it from the tendinous origination of the *Muſculus Biceps* of the Arm, which in paſſing from the brim of the *Acetabulum* of the *Scapula*, over the Head of the *Os Humeri*, has no Membrane intervenes between that and the Bone, but is immediately contiguous to it.

When the morbifick Humour is acid, and flows into the Receptacles, as I may call them, of the Mucilage, or Interſtices of the Joynts, and *Sinuſes* of the Tendons, and comes to be mixt with it, the effect will be the ſame, or like that, which I obſerved in the Experiments I made upon it with *Aqua Fortis*, Spirit of Nitre, &c. that is a Coagulation, as I have ſhewn before, when I treated of a Rheumatiſm. And this may give us the reaſon, why the Gout not only is often fixt in one place, but remains ſo long, and obſtinate. For when the matter happens thus to be thick, and gelatinous, it is not to be expected, that it ſhould be eaſily, and preſently diſcharged out of the Interſtices of the Joynts either by being reſorbed, or evaporated, when the conſiſtence of it renders it uncapable of inſinuating it ſelf into the minute Pores, and penetrating thoſe narrow avenues, through which it is to paſs. And according to the degree, and nature of the acid in the morbifick Humour, it does more or leſs Coagulate the Mucilage; and the part affected is ſooner, or later, with more or leſs difficulty freed from it either by the tranſlation of it to another, or by the more happy excluſion of it out of the Body.

As from the *Hypotheſis*, by which I have endeavoured to explain the nature, and cauſes of a Rheumatiſm, and Gout, we may be able to ſolve the reaſon of all the Symptoms in an ordinary *Arthritis*; ſo from ſome of the Experiments, which I have given a relation of it ſeems to be no difficult thing to account for that tophaceous Matter, which is ſometimes found concreted in thoſe parts, that have been afflicted with this Diſtemper. I did then particularly obſerve, that an Acid, and an Auſtere being both mixt with the Mucilage did produce a plain, a notable, and white Coagulation, where the *Coagulum*, though it was made when the Mucilage was cold, was not ſo ſoft, and tender, nor diſſolvable in water like that, which was made with Acids only; but though it would break, remained diſtinct in it, and being dried was eaſily reducible to a fine powder like flour, or the fine powder of Chalk. Now therefore I do humbly conceive, that where-ever the

Gout comes to be nodoſe, there is not only an acidity in the preternatural Humour, which is ſeparated by the mucilaginous Glands, and mixed with the Mucilage, but it is an acid-auſtere, which is no ſooner thrown into the Interſtices of the Joynts, and the *Sinuſes* of the Tendons, which are thereabouts, but but it produces a *Coagulum* in the Mucilage, and that ſuch a one as is not eaſily attenuated, and diſſolved, ſo that it lies fixt, and impriſoned there, and in time as the aqueous, and moiſt Particles are by the heat, and Spirits carried off, the Terreſtrial and Saline parts concentrated come nearer together, and coming to be immediately contiguous do mutually adhere, and are concreted, ſo as to produce that Chalk or Tophaceous Matter, which is in ſome arthritick caſes to be obſerved. And as the *Coagulum*, which may be made by an acid-auſtere ſeems apt to make a Concretion of that nature, ſo the colour of the Tophaceous Matter does anſwer to that of this Coagulation, ſo as to ſeem generated in this manner.

I might here from ſome of thoſe Experiments I gave an account of, obſerve how proper ſome preparations from Tartar, Spirit of Salt Armoniack, and thoſe of the like nature appear to be in a Gout, where the Mucilage is coagulated either with an Acid, or an acid-auſtere, eſpecially when the *Coagulum* is firſt made, and before it is plainly Tophaceous. For when it has proceeded thus far, we cannot promiſe our ſelves much ſervice from them, when it ſeems to defie our Art, and Phyſicians themſelves confeſs, that

Tollere nodoſam neſcit Medicina Podagram.

And as Medicines of this nature are internally convenient, when the Mucilage is coagulated, ſo external Remedies of the ſame nature are certainly reaſonable, and none that I know of ſeem to carry in them ſo much efficacy. Therefore I cannot but think that, that, which Dr. *Willis* preſcribes in his Chapter *de Arthritide*, a Solution of Salt of Tartar, and Salt Armoniack in Spring, or Rain-Water is an excellent fomentation in this caſe. However if it be uſed as it is preſcribed without any diſtinction, and reſpect to that particular Humour, which cauſes the Gout, and the Coagulation, which it produces, it muſt neceſſarily, as the Humour is not always the ſame, ſometimes deceive our expectations, as no remedy will anſwer them, but when it is oppoſed to ſuch morbifick cauſes, as it is apt to remove.

It is a common Rule, and Obſervation in this Diſtemper, that the Catharticks, which are uſed, ought to be very ſtrong, which eſpecially in caſe of an Acid, and a Coagulation will hold true. The reaſon of which will appear, when we conſider that the excluſion of the morbifick Humour from the Maſs of Blood, and the ſeparation, which is made by the mucilaginous Glands is Critical, ſo that it is requiſite they ſhould be ſufficient to alter the manner of the *Criſis*, and to turn the Humour into another Channel. But the principal reaſon ſeems to be, becauſe the matter to be excerned is viſcous, ſuch as is not apt to be exagitated, nor eaſily removed out of the Cavity, in which it is lodged. But it ſeems reaſonable, and neceſſary to attenuate the matter both by the internal, and external uſe of ſuch means, as will diſſolve a *Coagulum*, before they are exhibited. And if this be firſt done, perhaps more moderate Purges may be ſufficient, and anſwer our intention more effectually.

The *Hypotheſis* of the Great, and Immortal Dr. *Willis* concerning the cauſe, and *Ratio formalis* of the Gout, is indeed very ingenious: But yet, if I may without the ſuſpicion of arrogance diſcover my diſſent from him in this thing, I cannot but ſay, that as there is no evidence or proof of the accumulation of an Acid from the Nerves to ſome *particulæ Salino fixæ* ſuggeſted from the Blood, from the congreſs of which he ſuppoſes there ariſes a fermentation, ſo neither could I ever obſerve by any Experiment ſuch an efferveſcence, as he ſuppoſes, when I have at any time poured an Acid to the Mucilage, though it was ſenſibly ſalt. Neither is it neceſſary to ſuppoſe ſuch an Ebullition, or Conflict between the morbifick Particles to make them painfully injurious to ſuch ſenſible parts, as the Fibres. There is no body will queſtion, but an Acid, an Acrious, or a Saline Matter, unleſs it be conveniently temperated, will without ſuch a commotion, and only by contact be uneaſie to them, and excite ſuch acute pains, as we have in this Diſtemper. Therefore this ſuppoſition, as I conceive, is made rather to explain the Cauſe of the *Tophi*, than the reaſon of the pains. For the Doctor from the obſervation of a Coagulation made by the mixture, and after the efferveſcence of Spirit of Vitriol with Oil of Tartar ſuppoſes it probable, that from the mixture of an Acid derived from the Nerves, and of a fixt Salt from the Maſs of Blood, made in and about the Joynts, there follows firſt an efferveſcence, and at length from various Fermentations, and Coagulations of them there is generated a Tophaceous, and chalky Matter. But what I have offered with a deſign to explain the manner, how theſe *Tophi* are produced ſeems confirmed by ſome Experiments, and ſuch as were made with the very Liquor, which is actually ſeparated about thoſe parts, and to be found, where the Tophaceous Matter is generated, and ſo comes nearer to a Demonſtration.

According to that *Hypotheſis* the Matter, which is the cauſe of the Gout, is to be always the ſame, to wit an Acid from the *Genus Nervoſum*, and a fixt or *Alchalizate* Salt from the Maſs of Blood, which if it were ſo, I do not ſee, how there ſhould be ſuch a difference in the effects of the ſame Remedies: For if there be at no time a difference in the morbifick Matter, that, which is beneficial to one, would as certainly relieve another, and ſo every one that labours under this Diſtemper, allowing only for the various degrees of Concretion in the coagulated Matter, which is contradicted by daily experience: So that we muſt conclude there is ſuch a difference in it, as I have ſuppoſed, at leaſt, that it is not always of the ſame nature.

I ſhall ſay no more concerning this Subject, only as the nature, and effects of ſome Remedies, which I have known uſed in the Gout, have agreed with the Notion I have of the Cauſes, and Nature of it, and confirmed me in my Opinion, ſo I have ſatisfied my ſelf about the Etiology of their effects, and the manner of their operation from my *Hypotheſis*, and perhaps, if it be well conſidered, it may lead us to more rational, and effectual means, and methods of Cure, than are now made uſe of. Which it is not proper at this time to inſiſt upon, when the deſign of my Diſcourſes ſhould confine me to Anatomy, and natural Philoſophy, and every incurſion into the Province of Medicine is a running away from my Argument.

The FIFTH
DISCOURSE
OF THE
CARTILAGES.

THus I have purſued the method I at firſt propoſed, as far as the Cartilages, which though I cannot call Bones, yet ſo nearly are they allied to them, that it is not very ſtrange to find them ſtept out of their own form into the *Claſſis* of Bones, and therefore it will not be improper, though the Argument be different, to carry on my Diſcourſes, with thoſe Obſervations I have made of them, and with the account of their Nature. In ſome Fiſhes all the Bones, if I may ſo call them, are no other than Griſtles, and there are in Man the moſt perfect of all Animals ſome of them, that continue cartilaginous for ſome conſiderable time after the Birth, and are in the ordinary courſe of Nature converted into Bones. The preternatural mutation of them of the *Aſpera Arteria*, of the *Cartilago Enſiformis*, and ſome others into Bones is no more, than has been obſerved. So in Horſes, Oxen, and ſome other Beaſts this change is not very rare in the Cartilages of the *Thorax*.

But notwithſtanding the aptitude there is in the Cartilages to become Bones, yet the difference, when they are one, and when they are the other is conſiderable. Firſt in their ſubſtance, and conformation. The ſubſtance of the Cartilages is ſofter, and the parts of them more eaſily divided with the Knife, neither have they any large Cavities as ſome, nor any ſpongious part, as all the Bones have. And whereas the Wall, or that, which makes the ſides of a Bone is the moſt ſolid part of it, I have in ſeveral Cartilages obſerved it to be quite contrary, to wit, that the exterior part was the ſofteſt, and moſt flexible.

Secondly, They differ in their flexibility. The Bones are rigid, and more tenacious of their figure, the Cartilages are flexible, and more apt to be conformed to thoſe figures, which the force, that bends them, would oblige them to.

The reaſon of this flexibility in one above the other is the difference, there is as to the union of their Particles, which in a Bone are at their extremities ſo united in every ſeries, as to form a continued and an entire ſtring, and when all inflexion obliges the extremities of ſome Particles either to recede, as where the convex is elongated, or to approach nearer to one another, as when the Concave is ſhortned, conſequently that Body, in which they are ſo united, that they can do neither, muſt be rigid, and unapt to be bent.

The flexibility of the Cartilages ariſes, as in all other Bodies, that may be bent without injury, from the poſition, and figure of all, or at leaſt ſome of their Particles, as well as from the diſunion, and diſtinction of their extremities, which are of a long figure, and have a ſtreight poſition, ſo that one extremity looks towards one, and the other towards the other end of the Body, which they are the parts of.

Beſides the long figure, and the ſtreight poſition of theſe Particles, there is a certain order obſerved in the placing, and diſpoſition of them, which is ſuch, that the extremities of thoſe in one Series do not terminate juſt, where the extremities of the Particles, which are in the Series next to them, do; but they lie beyond them, and reach to ſome intermediate part between the extremities of thoſe Particles, which lie next to them laterally, as I have expreſt in the third Fig. Tab. II. For as the extremities of the Particles in a flexible Body muſt be diſtinct and their figure ſuch, that thoſe, which lie in one Series may be capable of moving, and ſliding upon them, which are contiguous to them in the next, ſo muſt their poſition, and order be ſuch that they may ſlip, and the extremities of their Particles may not only approach nearer to but recede from one another without interrupting the continuity of the Body. For want of the firſt of which the Body would be inflexible, and from a deficience in the other, it would be inevitably broken upon being bent when any part of it is elongated. But upon theſe ſuppoſitions we may eaſily conceive how a flexible Body may be inflected without a diſſolution of the continuity of it, even when the convex part is lengthned, and the extremities of the Particles recede one from another. Where they are driven cloſer together, it is true, there is no reaſon to think, that a Fracture ſhould be the conſequence of an Inflexion though the extremities do not lie in this order. But without doubt in the bending almoſt of all Bodies there is an elongation of one ſide, even when the other is ſhortned, and ſuppoſing the alteration, which is made in the poſition of their Particles to be by their recedure, yet ſtill the Body will be as ſecure againſt a Fracture, and as capable of being inflected without any injury, whilſt the order of its parts is ſuch as I aſcribe to them: As ſuppoſe in the fourth Fig. Tab. II. *a, a, a, a,* to be four Series of Particles lying contiguous to one another laterally, and making one Body, ſuppoſe thoſe of the firſt, and third Series, which have their termination about the middle part of them, which lie next to them in the ſecond, and fourth, to be moved, and to ſlide at one end towards *b,* and in the other part towards *c,* ſo as to elongate the whole Body, we may apprehend, how they may move both ways, and ſlip upon the Particles, which are laterally contiguous to them, without any injury to the continuity of the whole, and until they come as far as *d,* or the Interſtices between the extremities of the Particles in the ſecond, and fourth Series there will be no Fracture. But when they are forced ſo far, that one of their extremities is brought to thoſe Interſtices, there will neceſſarily follow a *ſolutio Continui.* And this is the reaſon why a Body, when it is too much inflected, breaks, and why it is broken firſt in the convex part, for on that ſide is the recedure of the extremities of the Particles, and the nearer they lie to the ſuperficies there, the more conſiderable it is, and conſequently they are firſt brought to the Interſtices between the extremities of thoſe Particles, which lie next to them laterally.

Not, that I ſuppoſe, that all the Particles in every flexible Body obtain ſuch a poſition, or that every one of them, that lie in the ſame Series, are capable of receding from, or moving nearer to one another, but there are ſo many, that are, as anſwer to the degree of inflexion, that the Body is capable of *ſalvâ continuitate.* And according to the number and proportion of the Particles, that are of a ſtreight figure, and thus poſited, and according to the length of them, and the diſtance of the extremities of the Particles in one Series from the extremities of thoſe, which are contiguous to them laterally, the Body may be more, or leſs inflected without a Fracture.

Beſides their flexibility, the Cartilages have ſome rigidity, and a power of reſtitution or recoyling, when they are bent, which is very evident in the *Epiglottis*, though it be not ſo rigid as ſome other Cartilages, which has no Muſcles to pull it up, but does after it has been depreſt by the deſcending Food riſe by its own innate power of reſtitution into its natural poſition, which reflection may be obſerved in it after the Animal is dead, when it is preſt down upon the *Rimula* of the *Larynx*.

This ſeems to ariſe from the Air; ſometimes from the preſſure of the external Air, ſometimes from an *Aer inſitus* included in the Interſtices of the Body it ſelf, but generally from both. As I have ſhewn, that it is neceſſary the extremities of the Particles in a flexible Body ſhould be diſtinct, ſo we may reaſonably think, there are ſome *Spatiola*, or Interſtices between them, (nay in many Bodies, which are rigid, they are very viſible,) in which there is an impriſoned Air, which, as it is evident from innumerable Experiments, is endued with an Elaſticity or Spring. So that whatever preſſes upon its Spring, and as it were winds it up to an extraordinary height, will cauſe a ſenſible renitency in it, and an endeavour to expand it ſelf, and this reſiſtance in the Air, when it is crowded into a narrower ſpace, than is convenient to the nature of it, is that which gives a recoyling Body the power of reflection, and obliges it, after it is bent, to return to its former figure, in which the *Spatiola* within it obtain their natural capacity, and the Air which is compreſt recovers the liberty of expanding it ſelf.

When the concave part of any rigid Body, that is bent, is ſhortned, and the extremities of the Particles are preſt nearer to one another, the Interſtices between them will neceſſarily be rendered leſs, and the Air included in them will be compreſt, ſo that the Spring muſt be, as it were wound up, and the natural conſequence of this compreſſion will be a renitency in the Air, or an endeavour to drive the Particles into that poſture, and the whole Body into that figure, that will reſtore the natural capacity of the Interſtices, which was accommodated to the quantity of Air contained in them. The ſtrength, and powerful reſiſtance of the aereal Spring, when the Air is contracted into a narrower ſpace, than what it uſually, and naturally expands it ſelf in, is evidently ſeen in the uſe of a Wind-Gun, where a greater quantity of Air is crowded into it, than the ſpace, which it is confined to, is capable of containing without a violent compreſſion, and running up the Spring of it to an extraordinary height, and when the Gun is diſcharged, when the included Air has the liberty of dilating it ſelf, and relaxing its Spring, we find with what a force it exerts its elaſticity.

But when the convex part of a recoyling Body is elongated, when the extremities of the Particles on that ſide recede from one another in inflexion, the preſſure is then not upon the Air, which is included in the Interſtices of the Body, but upon the external Air. Foraſmuch as the *Spatiola* between the extermities of the Particles are inlarged, ſo far the Body incroaches upon the Atmoſphere, and ſo long as the external Air is excluded, and has not the liberty of filling up what is added to the capacity of the Interſtices, there is nothing to anſwer for that ſpace which the *Atmoſphere* loſes, ſo that the external Air muſt neceſſarily be compreſt, and the Spring of it heightned. Thence follows in it an endeavour to drive back the Particles of the inflected Body into their natural poſition, and to reduce the *Spatiola* of it to their former capacity, which cannot be be done without the reſtitution of the Body to a more ſtreight figure. An effect of this nature from a preſſure upon the external Air we have formerly ſeen here in an Experiment made by *Monſieur Papin* before this honourable Society, which was done with the Barrel of a Gun fitted to the Air-Pump. In which Experiment the Air being exhauſted out of the Gun, and obtruded upon the external Air, and the external Air being excluded from the Cavity of the Barrel, ſo that it could not obtain any ſpace to anſwer for that, which the evacuated Air then occupied, it was compreſt,

preſt, and the Spring of it conſiderably heightned, which afterwards appeared, when the breech of the Barrel was opened, and the external Air had the liberty of expanding it ſelf; for it ruſht in with that violence, and exerted the power of its Spring ſo much as to ſhoot the Bullet, with which the Gun was charged, with a great violence.

I have been the longer inſiſting upon the nature of flexible Bodies, and made it one part of my buſineſs at this time to explain the reaſon, why thoſe, that have a rigidity, do recoil not only to ſhew why the Cartilages may be bent without breaking, and how they endeavour to return, after they are bent, to their natural figure, but becauſe I deſigned, that what I have ſaid concerning the flexibility, and power of reſtitution, which are in ſome Bodies ſhould ſerve as ſome account of the nature of theſe parts, of the Particles, which they conſiſt of, and of the order, in which theſe Particles are diſpoſed. Now therefore to make a particular application of what I have ſaid of the nature, and parts of a flexible and recoyling Body, to the Cartilages, the figure of their Particles is long, and they are ſmooth, their poſition ſtreight, their extremities diſtinct, between which there are Interſtices, and in theſe Interſtices is an included Air, the Particles are diſpoſed in a certain order, ſo that in every Series they reach with their extremities to ſome intermediate part, or near to the middle of thoſe, which are next to them laterally, and lie quite over the Interſtices, which are formed between the extremities of thoſe on their ſides, whereby the *Spatiola* are incloſed, and the Air contained in them is ſtrictly impriſoned.

From hence we may underſtand, wherein the difference between a Bone and a Cartilage does conſiſt, that in one the Particles are united at their extremities ſo, that every Series makes a continued, and compleat ſtring, whereas in the other they are diſtinct, and there are little diſtances, or cavities between their ends, ſo that they are in every Series capable of being driven nearer to, or forced farther from one another. And this is the alteration, that a Cartilage undergoes when it becomes a Bone, to wit, the Particles at their extremities are ſo nouriſhed, and receive ſuch an addition, as to touch one another there, to unite, and acquire a continuity, which makes them in every Series form an intire ſtring, when the implanted Air has a paſſage out of the Interſtices, and gives way to that Nouriſhment, whoſe acceſſion it did before reſiſt. By this union of the Particles the temper of it is altered, and it being difficult to diſingage, and part them, it grows firm and inflexible.

The terreſtrial parts, and the fixt Salt in the Cartilages, whilſt they obtain their proper nature, are much leſs in proportion to the other parts, than they are in a Bone. For I find there remains after Calcination but about a fifteenth part.

The Cartilages have a Membrane, as the Bones have, which to ſpeak properly we muſt call the *Perichondrium*, though it is in a manner the ſame, and a continuation of the *Perioſteum*, conſiſting of the ſame ſort of threads, being of the ſame texture, and every way ſo agreeing with it, that I need not ſtand to give a particular account of it. Neither does the uſe and deſign of the *Perichondrium* differ from them of the Membrane, which immediately covers the Bones, it ſerves to cloath the parts, and helps to ſet bounds to their Accretion, it ſupplies the want of Nerves in them, gives them a ſenſibility, and affords them thoſe Spirits, which are neceſſary to aſſiſt in their increaſe; and is a *medium*, whereby the Tendons of the Muſcles are fixed to thoſe Cartilages, which have any of them inſerted into them as thoſe of the *Larynx*, and ſome others. But in thoſe, that are joyned to any of the Bones, it ſeems to be chiefly ſerviceable in ſtrengthning their conjunction. For though there be another contrivance for joyning of them, yet when this Membrane is taken off, or divided round that part, where they meet, they are eaſily ſeparated.

For ſtrengthning the adheſion of the *Perichondrium* to the Griſtles, and conſequently to make the conjunction of the Bones, and Cartilages, which are united, and the union of any part, that appertains to them, more firm, they have little Furrows, and ſuperficial Pits, or depreſſions ſo to inlarge their ſuperficies, where their Membrane is applied, and adheres to them, which it does partly by an immediate contiguity, which manner of Conjunction, as I obſerved, when I gave an account of the *Perioſteum*, is ſo much the more firm, as the ſurface where two Bodies, ſo united do immediately touch one another, is larger, and therefore this Membrane has on that ſide, which lies next to the Cartilage, inequalites, and protuberances exactly fitted to, and filling the ſuperficial Cavities, which are formed in the part it adheres to.

But beſides this manner of Conjunction, their Membrane is united to them by ſmall *Fibrillæ*, or threads, which enter ſome way into their ſubſtance, as thoſe of the *Perioſteum* are inſerted into the Bones. By theſe are ſupplied the Spirits, which ſerve in their Accretion, and by whoſe mediation we may reaſonably ſuppoſe, that the Cartilages have ſome other ſenſe, than what is external, and merely in their Membrane.

Though they preſent us with a whitiſh colour, they are not deſtitute of Blood Veſſels, but they have abundance of them, ſo that in the ſingle *Cartilago Thyroides* I have ſeen ſome hundreds of Pores, by ſome of which ſome of the Veſſels paſs'd into it, as by others ſome of them had their egreſs. Theſe all ſerve only fortheir Accretion, and Nutrition.

The Cartilages do not ſeem to have any medullary Oil ſeparated within them from their Arterial Blood. For though they evidently ſtand in need of ſomething of that, or the like nature, and when I have traced the Blood-Veſſels, which run along commonly in the middle of thoſe Cartilages, which are of a long figure, ſo far as the part where I thought they had their termination, I have ſometime found an oily ſubſtance beyond it, yet I could not diſcover any Veſicles, or Glandules for the ſeparation of it, ſo that that Oil ſeemed to be ſupplied from the Bone, to which it was united. Thus in my account of the Marrow I ſuppoſed ſome part of the medullary Oil to be aſſigned to the Cartilages, where they are joyned to any Bones, and I obſerved that there are Pores, which I cannot but think are formed for the communication of it from one to the other.

For the joyning of thoſe Cartilages to the Bones, which are united to any of them (beſides the ſervice of their Membrane, which I have taken notice of) the Bones are formed in that part, which is applied to them with ſome conſpicuous Protuberances or ſhort and obtuſe Roots, and other leſſer Radicles, which are numerous, and ſtand thick together as well in thoſe Protuberances as in the other parts of that end of the Bones, by which they are a little way implanted into the Cartilages.

Of the U S E *of the* CARTILAGES.

THE uſe of the Cartilages in general is no obſcure thing. We muſt conſider, that there are ſome parts of the Body, which require a greater ſtrength and ſolidity, than was agreeable with the nature of the Fibres, or Ligaments, as they are neceſſary for the defence of ſome tender, and noble Parts, or for the Dilatation of ſome paſſage, to keep it diſtended, and to reſtore it to its natural capacity, when it has been compreſt, and ſtreightned; and yet withal it was no leſs requiſite, that they ſhould be more flexible, than the Bones, and ſo pliable, as to alter their figure, when the motions, and actions of ſome of the parts, which they either protect, or are united, or adjacent to, do require it. Now to make a Part both ſolid, and flexible, and ſo capable of anſwering both theſe intenſions, Nature has formed the Cartilages, which are of a middle temper between a Bone and a Ligament, that partake of the firmneſs, and rigidity of one, and the flexibility of the other, and they are made uſe of wherever a firmer part than a Ligament, and a more pliable ſubſtance, than a Bone is required. And it were an eaſie thing to ſhew, how all parts of this Conſtitution are neceſſary, and ſerviceable in every part, where they are planted: But I think it not needful, ſince every one, that does but view, and conſider the parts, which they are appointed to, may have the proſpect of them, and the reaſon of this contrivance at the ſame time. I ſhall only give my thoughts particularly concerning the uſe of the Cartilages, which are united to the true Ribs, becauſe their uſe, and the manner, in which they are ſerviceable in Reſpiration ſeems to be imperfectly explained, and not truly underſtood.

Any one may be ſenſible, how improvident Nature had been, if ſhe had made the Walls of the *Thorax* fibrous, and placed two of the greateſt Engines of Life without a ſolid defence on thoſe ſides, which are obnoxious to external preſſures, and injuries. But as theſe parts were to be protected, ſo there is the neceſſary action of

Reſpiration, which as it was not to be interrupted, nor the parts inſervient thereunto to be injured by external violence; ſo there muſt be ſome contrivance, that it may not be hindered by the ſtructure and nature of the parts, which incloſe the Cavity of the Breaſt. If the Cartilages of the Breaſt had been Ligaments, or only membranous, the Heart, and Lungs could have had no defence and ſecurity againſt the impreſſions, which the violence offered to theſe parts had been apt to make upon them. If they had been plainly Bones, that Bow, which lies between the *Sternum*, and the Vertebres had not been capable of an Elongation, which is certainly the thing deſigned in making ſome part of it cartilaginous, that by the reducing of that part to a more ſtreight figure both the Vertebres, and Breaſt-Bone may be protruded.

The learned, and ingenious Dr. *Mayo* has given us a good account, how the Ribs do contribute to the ampliation of the Breaſt by the alteration of their poſition, and being raiſed from that Plane, which divides the Cavity of the Breaſt into two equal parts, towards which they did before incline, be it the *Mediaſtinnm*, or be it imaginary,

nary, ſo that whereas before they made acute, they come to form right Angles with that Plane. For the Ribs, as he obſerves, are not articulated with the Spine, and Breaſt-Bone at right Angles, but ſo as to form acute Angles beneath themſelves, and he ſuppoſes the Cartilages are joyned to them to add to their length, and for augmenting the Concave of their Arch. And this is demonſtrable, that if ſeveral Bows, or incurvated Bodies as the Ribs are, lying upon, or inclining to a Plane, be ſo raiſed as to reſt upon their extremities, and to make Right Angles with that Plane, they will form a large Cavity under their Arches. But if this were the deſign of the Cartilages, the Ribs would have done this as well if every one of them had been a continued Bone from the *Sternum* to the Vertebres. Therefore I conceive, that they are intended to make the Ribs more capable of altering their figure, and ſo contribute another way to the dilatation of the Breaſt. I ſhall not then be affraid to aſſert, that the Cartilages do ſome particular way add to the capacity of the Breaſt in Inſpiration, as I doubt not, but they likewiſe act a part, and aſſiſt in the Contraction of it, when the Air is forced out of the Lungs.

Firſt I ſay they help in inlarging the Cavity of the *Thorax*, not merely by being raiſed from the Plane, towards which the Ribs incline, when the Air is evacuated, but by altering their figure, when they aſcend towards the Clavicles. For if we ſtrictly obſerve the ampliation of the Breaſt, when we draw in the Air, we ſhall find, that there is ſomething more added to the Capacity of it, than what can proceed from the elevation only of the Ribs, it will appear to any one, that takes notice of it, that the Vertebres of the *Thorax* are driven outwards, and the *Sternum* though not ſo ſenſibly is protruded, when we inſpire, which cannot be effected by the elevation of the Ribs, and their forming Right Angles, with that Plane, from which they are raiſed. For although this does inlarge the Cavity of the Breaſt in that part, which is under their Arches, yet this elevation alone does make no alteration in their Longitude, without which it is impoſſible they ſhould protrude both thoſe parts, that are joyned to their extremities, at the ſame time. For ſo long as the diſtance between their extremes is the ſame, when they are pulled up towards the Clavicles, as when they deſcend, this alteration of their poſition only can no ways thruſt forth the parts, which are fixed to their extremities.

Therefore to ſolve this thing of the protruſion of the Vertebres and *Sternum* in Inſpiration, we muſt ſuppoſe, when the Ribs aſcend, ſuch a change of their figure in ſome part of them, as makes an addition to the length of the whole. And we ſhall ſee how this is done, if we obſerve the figure of the Cartilages, that are joyned to the true Ribs, how it is a ſort of an Angle, ſo that as this Angle is more or leſs Obtuſe, the extreme part both of the Rib, and Cartilage, recede farther from, or come nearer to one another. So that when the Ribs deſcend, and incline towards their Plane, and their Cartilages obtain their natural figure, this Angle, as it is always obtuſe, comes nearer to a Right Angle, but when they are drawn up, it is rendered more Obtuſe. And as the alteration of their figure when we draw in the Air, and the reſtitution of it in expiration require their flexibility, ſo I have obſerved theſe Cartilages to have continued cartilaginous, and flexible, where this Angle has been, when the reſt of the Cartilage has been of a bony nature, which confirmed me in my Opinion, that this angular part of them is particularly deſigned for their elongation at that time, when we inſpire. Now this is capable of a Demonſtration, that as an Angle becomes more Obtuſe, and it approaches nearer to a ſtreight Line, the diſtance between the extremities of the two lateral Lines, which form it, will be increaſed. So it is here, the Angle of the Cartilages being rendered more Obtuſe by the contraction of the Intercoſtal Muſcles, and they being reduced nearer to ſtreight figure, when the Ribs are raiſed, their extremities do neceſſarily recede from each other, and conſequently thruſt out the *Sternum*, to which they are united at one end, and drive back the Ribs, which are joyned to the other, by the mediation of which they protrude the Vertebres. And if this were not the deſign of that angular figure, which theſe Cartilages obtain, to wit, to add to the Capacity of the Breaſt by the protruſion of thoſe parts, but only to inlarge the Cavity or Arch under the Ribs in their elevation, I do not ſee why Nature has made this difference between their figure, and that of the Ribs and did not rather give them both the ſame obliquity ſo as to make one exact Bow of them both. Nay why has Nature made any ſuch thing as Cartilages here, and filled up ſome part of the diſtance between the Vertebres and *Sternum* with a ſubſtance of a flexible temper, if it were not with this deſign to make them capable of an elongation, when if every Rib had been a continued Bone to the *Sternum*, and had had no ſuch thing as a Cartilage joyned to it, it had with an Articulation at the Breaſt-Bone been as readily diſpoſed to aſcend towards the Clavicle, and would have formed the ſame Arch, as it does with it, if we ſuppoſe no alteration in the figure of this part.

I have ſecondly made theſe Cartilages to conſpire in expiration, to prove which we muſt conſider, that they obtain their proper figure, and their parts have their natural poſition only, when the Breaſt is contracted, and becauſe there cannot be ſuch a change in the figure of the Cartilages, as renders their Angle more obtuſe, than it naturally is, without the ſame diſturbance to their Particles, and the ſame alteration in their Pores, or the Interſtices between the extremities of the Particles, as there are upon the inflexion of any rigid Body, (for what inflexion is to a Body that is ſtreight, the ſame is extenſion to that, which is crooked) therefore there muſt neceſſarily be a preſſure upon the Spring either of an internal, included Air, or of the external Air, as the Convex is ſhortned, or the Concave is elongated: For in the extenſion or reducing of an oblique Body nearer to a ſtreight figure, different from what it is in the bending of one that is ſtreight, when there is an elongation, it is on the Concave, and the abbreviation is on the Convex part.

Theſe Cartilages therefore having from the Spring of the Air a power of reſtitution, will, when their figure, and the capacity of their Pores are ſo altered, as to make a preſſure upon it, recoyle, and without the help of any Muſcles return to their firſt figure, as we ſee in the *Epiglottis*, which is not ſo rigid. By this power of reſtitution they are one cauſe of their own, and of the Ribs ſubſidence, whereby they contract the Cavity of the Breaſt, and by making a preſſure upon the inflated Lungs contribute to the expiration of the Air, which diſtended them. And this is one great reaſon, why the *Thorax* is contracted in all dead Bodies. This we cannot think proceeds from any action of the Muſcles, which ſerve for expiration, unleſs we will ſuppoſe they are always the laſt that act, which ſeems to be improbable, when we have better reaſons to conclude that the inſpiratory Muſcles are the laſt of all theſe, that contract themſelves. Let them be which they will, this is certain, that after Death neither of them can modifie the Cavity of the Breaſt either by contracting or diſtending of it, whereas if the Lungs are then inflated, and the *Thorax* is dilated, ſtill it afterwards contracts it ſelf. And though this is partly to be aſcribed to the ſubſidence of the Veſiculous ſubſtance of the Lungs, yet if we conſider, that the reſilience, or reflection of theſe Cartilages, when they are extended, ariſing from the elaſticity of the Air, without any dependence upon the Animal Spirits the power of it remains the ſame, when the Body is dead, as it was before, and that they have ſtill a natural *conatus* to return to that Figure, which they cannot obtain without the depreſſion of the Ribs, and the contraction of the Breaſt, we cannot but think, that this is one thing, that determines the poſture of the one, the figure, and capacity of the other after Death.

FINIS.

ERRATA.

P*Age* 10. *Line* 3. *Read* are. *p.* 42. *l.* 18. for four *r.* three. *p.*56. *l.*20. *r.* render. *p.*87. *l.*10. *r.* does. *p.*95. *l.*15. *r.*places. *p.* 109. *l.* 5. *r.* Glandules. *p.* 146. *l.* 25. *r.* exactly to. *p.* 186. *l.* 5. *r.* an. *p.*199. *l.*21. for Glands *r.*Glandules. *p.*222. *l.*24. *r.*Joynts. *p.* 226. *l.* ult. for our *r.* one. *p.* 227. for it *r.* the matter. *p.*233. *l.* 15. *r.* they.

A Catalogue of Phyſick Books lately Printed for Samuel Smith, *at the Prince's Arms in St.* Paul'*s Church-Yard.*

PRaxeos *Mayernianæ* in Morbis internis præcipue Gravioribus & Chronicis Syntagma, ex Adverſariis, Conſiliis ac Epiſtolis ejus, ſummâ Curâ ac Diligêntia concinnatum. 1690.

Phthiſiologia ſeu Exercitationes de Phthiſi tribus Libris comprehenſæ. Totumque Opus variis Hiſtoriis illuſtratum. Autore *Richardo Morton*, Med. Doct. & Regii Collegii Medicor. Lond. Socio. 1689.

De Morbis Acutis Infantum. Autore *Gualtero Harris*, Med. Doct. Celeberrimi Collegii Medicorum *Londinenſium* Socio, atque Cenſore. 1690.

Synopſis Methodica Stirpium Britannicarum, in qua tum Notæ Generum Characteriſticæ traduntur, tum Species ſingulæ breviter deſcribuntur: Ducentæ quinquaginta plus minus novæ Species partim ſuis locis inſeruntur, partim in Appendice ſeorſim exhibentur. Cum Indice & Virium Epitome. Auctore *Joanne Raio*, è Societate Regia. 1690.

Pharmacopœia *Bateana.* In qua, Octingenta circiter Pharmaca, pleráque omnia è Praxi *Georgii Batei* Regi *Carolo* Secundo Proto-Medici excerpta, Ordine Alphabetico conciſè exhibentur. Quorum *Nonnulla* in Laboratorio Publico Pharmacopœano *Lond.* fideliter parantur *Venalia*: Atque in uſu ſunt hodierno apud Medicos *Londinenſes.* Huic acceſſit Orthotonia Medicorum obſervata: Annexa item eſt in Calce Tabula Poſologica Doſibus Pharmacorum quorundam expeditiùs computandis accommodata. Curâ *Ja. Shipton* Pharmacopœi *Lond.* 1688.

An Eſſay of the great effects of even Languid and Unheeded Motion. Whereunto is Annexed an Experimental Diſcourſe of ſome little obſerved Cauſes of the Inſalubrity and Salubrity of the Air and its Effects. By the Honourable *Robert Boyle*, Fellow of the Royal Society. 1690.

R. Boyle's Memoires for the Natural Hiſtory of human Blood, eſpecially the Spirit of that Liquor. 1684. Octavo.

——Experiments and Conſiderations about the poroſity of Bodies. 1684. Octavo.

——Short Memoires for the Natural Experimental Hiſtory of Mineral Waters. 1685.

——Of the reconcileableneſs of Specifick Medicines to the Corpuſcular Philoſophy; to which is Annexed a Diſcourſe about the Advantages of the Uſe of Simple Medicines. 1685. Octavo.

The Philoſophical Tranſactions, publiſhed by the Royal Society Monthly. Quarto.

Acta Eruditorum ab Anno 1682. ad An. 1690. Lipſiæ. Quarto.

Pharmacopœiæ Collegii Regalis *Londini* Remedia omnia ſuccinctè deſcripta; Atque Serie alphabeticâ ita digeſta, ut ſingula promptiùs primo intuitu inveſtigari poſſint. Editio Altera Priori Caſtigatior & Auctior. Huic annexus eſt Catalogus Simplicium, tum locupletior tum Compendioſior, quàm antehac Editus. Acceſſit in Calce Manuale ad Forum: Nec-non Pinax Poſographicus. Curâ *Ja. Shipton* Pharmacop. *Lond.* 1690.

116